RANDOMLY MIXED PERENNIAL PLANTINGS:

TRIAL RESULTS FROM BERNBURG/GERMANY PERENNIAL MIXTURE PROJECT AND APPLICATION IN IRAN

By

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"Master Thesis"

Submitted in partial fulfillment of the requirements

For the Master degree of Landscape Architecture

Anhalt University of Applied Sciences, Department of Landscape

Bernburg, Germany, 2017

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SUMMARY

This study is divided into 3 main chapters, in the first chapter challenges of perennial planting in city landscapes have been addressed, applicable strategies for perennial plantings in urban area have been explained and various samples of perennial plantings in Germany and other countries are illustrated. In this chapter the main concept and idea of "randomly mixed perennial planting" is presented and its requirements have been listed and in the last part, with the initial introduction of "Bernburg perennial mixture project" the main targets of this study have been clarified.

In the second chapter, applied material and methods in "Bernburg perennial mixture project" are introduced and the results of each method have been briefly analyzed. Bernburg project is explained with more details and characteristics of the city of Bernburg and research site have been illustrated. In this chapter suggested trials and their categorization based on different perennial mixture, soil type and irrigation pattern are introduced and according to their biological features and aesthetic aspects have been discussed. In this part, site preparation of Bernburg project is explained step by step through presented plans and photos of the process. In the last section of this chapter assessed methods in Bernburg project (computer simulation, grading system, monitoring, species' vitality, coexistence, height, number and weeds) along with their obtained results and affecting factors are stated and analyzed. As a conclusion of this chapter a comparison has been made between costs of a planting project by making use of artificial soil (free from weeds) and cost of maintenance in case of use of topsoil.

In the third chapter, by inspiring from Bernburg project and applied method in it, the idea of Iran's perennial mixture has been formed. In the first part of this chapter features of Iran such as climate, topography, ecosystem, flora, soil pattern and water resources are explained and then current city landscape of Iran has been criticized. A part of Iran (Ilam, Zagros Mountains) has been selected for proposal mixtures and selection methods of Iran's perennials in this region for final mixtures have been explained, chosen themes of plantings are illustrated and in the last part, 3 suggested mixtures are presented by making use of 54 recognized perennials in the area of study.

To my wife for her permanent companionship and support

ACKNOWLEDGMENT

I wish to express my thanks to my advisor Prof. Dr. Wolfram Kircher who gave me the opportunity to be a part of "Bernburg perennial mixture" project and guided me through my study kindly and sympathetically, and to Dr. Elke Eckhardt with her compassionate help and advices.

My sincere thank goes to Dr. Solmaz Tavakoli who helped me in a significant part of my study by her knowledge and information.

I am grateful to Dr. Madeleine Martin who provided me with a friendly and warm atmosphere to be able to go on with my study and I would also like to thank Daniela Jürges for her friendly guides and helpful information.

My very special thanks go to my parents my eternal life-couches and true supporters of my life and my wife with her permanent companionship and patience during my study.

DECLARATION of AUTHORSHIP

I certify that the material contained in this Master Thesis is my own work and does not contain unacknowledged work of others.

- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations the work of this thesis is entirely my own.
- This Master Thesis has not been submitted for the award of any other degree or diploma in any other institution.

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1. INTRODUCTION

1.1 Challenges in perennial plantings for city Landscape projects

Planting and city landscaping in many countries including Germany is limited to specific species and limited number of plants mainly shrubs and small number of summer blooming plants and evergreen ground covers. In most cases few problems in city landscaping are the main reason of limiting the options for green areas and not being interested to Perennial plantings.

A. Employee qualification (plant and care)

Nowadays city landscaping are suffering from lack of qualified employees for planting and care of perennials which can cause to choose inappropriate plants that can lead to high maintenance costs while concepts are needed for low-maintenance and easy-to-care for planting perennials.

B. Destruction

As a matter of fact all type of plants in city landscaping can be destructed by many reasons but in this case perennials are more vulnerable rather than shrubs and trees. These destructions can be divided to biotic and abiotic factors. Among biotic factors the damage or complete loss can happen by insects, mammals and birds or fungal and viral infection, animal such as hares can uproot freshly planted perennials and birds such as pigeons, crows and sparrows which can damage them.

Vandalism is also another item which can cause damage or complete loss of perennials, whether intentional or unintentional, these damages can happen by children, youths or adults on bicycle, foot or any motor vehicle or even by their dogs.

Among abiotic factors climatic conditions is the main item. The effect of radiant heat on plantation in the city landscape or heavy rainfall and also in the inner cities duo to buildings and constructions such as asphalted streets plants can be negatively affected by road salt and snow slush and other problems such as air pollution are among problems with planting in public green spaces.

C. Planners and Caretakers (lack of knowledge)

Another problem with planting perennials is the fact that some planners or caretakers are not well informed about perennial planting and they are not well educated by responsible authorities therefore that workers need to get necessary information and be trained at work places otherwise the result of this lack of knowledge will be inefficient city landscaping.

1.2 Perennial planting strategies (in city landscape and public green areas)

According to "*Development of Randomly Mixed Perennial Plantings and Application Approaches*" (Kircher, Messer, Fenzl, Heins, Dunnet), and " *An Using and Designing Strategies of Perennial Plants on Urban Planting Design"* (Cengiz Acar, Hilal Kahveci) There are many different planning methods for large scale perennial planting but the most common approaches are;

A. Monoplanting a strategy based on planting with a single species and typical perennials used in this method are Geranium, Salvia and Lavandula, etc. It is a simple and popular perennial planting method in public green areas.

Figure 1.1

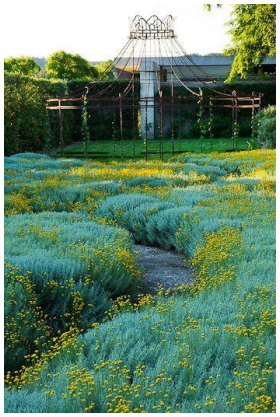


Figure 1.2

B. Planting in groups and blocks, usually more than two different species, Block planting is essentially a more complex version of the monoplanting and is perhaps the most common approach to landscape planting. Block plantings consist of several different species planted for effect in groups of three to five or more. (Messer, 2008)

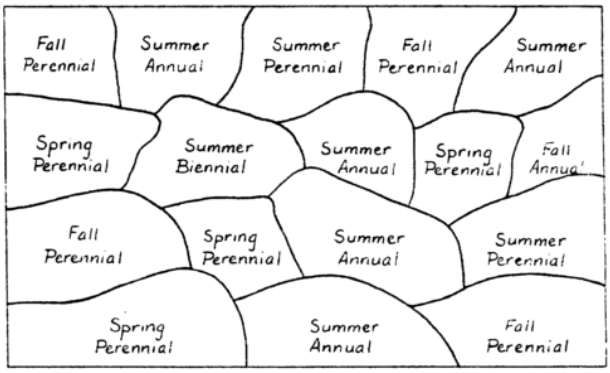


Figure 1.3

Figure 1.4

C. Drifts, it contains groups of plants arranged in extremely narrow rows running more or less parallel to the main direction of the bed. This arrangement enhances the depth effect, but is more expensive to plan and maintain. Drift planting was used with great skill by Gertrude Jekyll in herbaceous and mixed borders. (Messer, 2008)

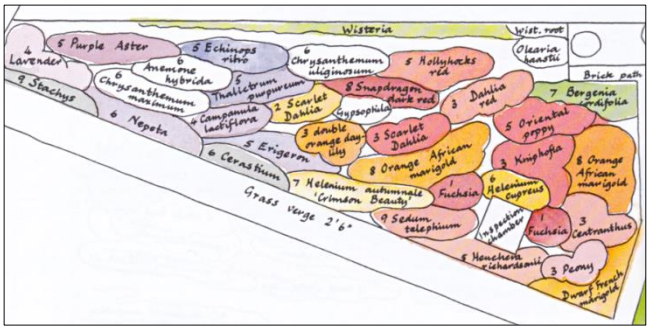


Figure 1.5

Figure 1.6

D. Planting by sociability, this planting strategy is applicable to perennials with a more indigenous or natural effect. Plants of low sociability levels are set individually or in small groups of three to five or five to nine.

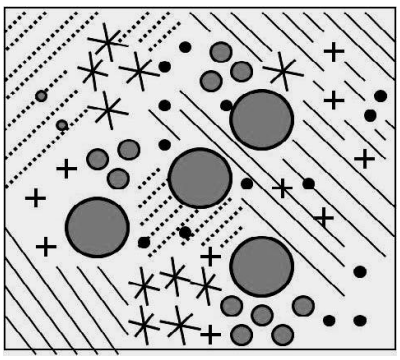


Figure 1.7

E. Random plantings, Distribution and placement of the plants are then carried out randomly following a list. The exact position of every plant is not predetermined in a planting plan, but determined by chance or by the gardener. This planting strategy gives a natural effect.

Figure 1.8: Bernburg perennial mixtures

Figure 1.9

1.3 Case study

The main concentration of finding similar projects is based on some main principles such as making use of native species and perennials, naturalistic planting design, planting with long lasting and low maintenance strategy, projects with developed perennial mixtures with the emphasis on minimization of maintenance and economical solutions, planting with a natural ecological focus and projects in leading countries in making use of perennial mixtures in city landscaping.

A. Thijsse's Hof garden (Jacobus Pieter Thijsse, Eli Heiman 1925)

Thijsse's Hof garden was created in 1925 in the Bloemendall forest in Netherland on the occasion of Dr. Jac. P. Thijsse's sixties birthday. Right from the beginning it was Thijsse's intention to present the native plants of Kennemerland in natural vegetations which develop (largely) spontaneously and by the effort of Thijsse and Heiman two naturalists it was officially first time that native plants with naturalistic mixture were used in a garden and the idea of using native perennials in city landscape was presented.

Planting strategy: Planting by sociability and random planting

Figure 1.10

Figure 1.11

B. German Perennial Nurseries Association (Bund deutscher Staudengärtner, BdS)

BdS based on Wolfgang Borchardt,Urs Walser and Wolfram Kircher ideas about herbaceous perennials in city landscape and public green spaces, developed "Silbersommer" (silver summer) perennial mixture and this mixed planting was awarded the 2006 prize from Bavarian state institute for viticulture and horticulture (Landesanstalt für Wein- und Gartenbau, LWG) for innovation in landscape gardening and it has been used in many public gardens and city landscape. Other mixtures also developed in LWG such as "Veitshöchheimer Blütenmosaik" and "Veitshöchheimer Blütentraum". Based on Urs Walser, herbaceous perennials in city landscapes are not the expression of fashion trend but reflect the natural source and environment of plants in a city's green spaces.

There are many mixtures which are developed by research agencies and unions such as LVG in Erfurt and Erfurt University of applied science and they have been used and successfully tested in public green areas, some of these mixtures are "Thüringer Blütensaum" (Thuringian flower border), "Feuer und Flamme"(fire and flame) and "Tanz der Gräser"(dance of the grasses).

Figure 1.12

Figure 1.13

C. Traffic islands in Austria

More than 10 years in Austria herbaceous perennials have been in use for traffic islands and the main species for plantation around traffic system in city landscape are Sedum, Salvia, Bergenia and Artemisia, for these species it is necessary to be free from weed and have well-drained substrate which can be applied successfully by making use of a layer of gravel to provide a proper covering against weed and also have an acceptable

appearance. As an evidence of this breakthrough in Austria Noel Kingsbury garden writer and researcher said "since I have driven round Austrian roundabouts it is just amazing to see how much perennials (in the 40-60 cm height range) are used in traffic islands and roadside environments. Really just about every place I have driven through in Oberösterreich seems to be amazing".

Planting strategy: Planting by sociability and random planting

Figure 1.14

D. Amstelveen's heemparks

According to *The enchanted heemparks of Amstelveen* book written by *Arlette Kouwenhoven and Arien slagt* "Amstelveen's heemparks are islands of peace and wonder, where plants and herbs that are indigenous to the Netherlands are shown in enchanting compositions. Wander in a typical Dutch polder landscape with pollard willows and reed lands in De Braak; repose in the romantic 'garden rooms' in the Dr. Jac P. Thijssepark, where rare varieties such as Marsh St. John's Wort, Cranberry and Dwarf Cornel once again exhibit their fragile beauty; and make the most of your opportunity to admire the very rare Molinia meadows in the Dr. Koos Landwehrpark that were part of the eastern

farmlands in days gone by. Experience the beauty of Dutch flora in any season during your stroll in these delightful parks."

Heemparks in Netherland which were created based on "Wilde plantentuinen" written by Cees Spike and also Koos Landwehr's efforts continuing the philosophy of Thijsse's Hof garden formed an expression "Heempark movement" in the Netherland on the basis of using indigenous plants in public parks and city landscapes and later on, in the city of Arnheim following this movement, public green areas has been covered by robust perennials.

Planting strategy: Planting by sociability and random planting

Figure 1.15: Romolen Heempark

Figure 1.16

E. Dreampark Enköping, Sweden

According to *"High–Value Urban Open Spaces"* written by Stefan Mattson Technical Administration, Parks and Sport Department of Enköping, Sweden" In the early 1980s when new strategies for park operations were drawn up, we queried certain aspects of the utilization of resources, including the status and commitment regarding the execution of several field projects. At that time, over 35 000 summer flowers were planted in borders and pots each year. The overall impact of these flower displays could in many instances be disputed. We were caught in a rut of routines regarding economy, work performance and design - recurring planting habits year after year. At the same time, the planting of the summer displays was regarded as the annual feast as far as the park attendants were

concerned. At that time there were no perennial plants in our park environment. So the question was could we reduce the summer flower displays and improve the rest? Would a long- term systematic utilization of perennials initiate professional engagement and at the same time produce beddings and parks of great inspirational and visual value?

We commenced on a limited scale to replace the annuals in certain spaces with perennials and this development increased in successive years. We learned the importance of using a soil free from perennial weeds and that adequate irrigation systems were essential.

The development of these planting communities, which are not traditional borders in the true sense but a harmonious mix of planting companions from trees and shrubs to hardy bulbs, has been a huge success. In 1982, the first 400 perennials were planted and since then the number of plants has increased to between 10 000 – 20 000 per year. Today an area of about 20,000 m2 is covered with perennials."

He continued "Influenced by the “Dutch perennial surge” we engaged the designer Piet Oudolf for the much celebrated composition “Drömparken”, created in 1996. Tall, perpendicular, cylinder-shaped beech hedges grow in combination with a variety of 220 different perennials. The visual effect created by the blue river of *Salvia nemorosa* is a much appreciated attraction. The abundance of ornamental grasses and other vertical growing perennials is an attempt to echo naturalness, drawing on an appreciation of natural habitats rather than a traditional garden. The colour compositions are subtle but distinctive forms and striking contrasts in height and growth habits, in foliage texture and seed head shapes creates the image of a brilliant firework display. The seasonal diversity of the perennials ensures a distinctive feature to the park. Even in winter the park still maintains its attraction when seed-heads and parchment-like grasses celebrate their beauty with breathtakingly frosted winter effects.

Twenty years of gradual adjustment to the combined utilization of perennials and summer flowers has meant that the municipal residents have been able to enjoy the parks even in times of economic recession. The professional status of the park maintenance staff has increased – skilled complexity results in greater commitment."

Planting strategy: Planting by sociability and planting in groups and blocks

Figure 1.17

Figure 1.18

F. Hermannshof Gardens (Germany, Weinheim)

The city of Weinheim itself located on a climatic sweet spot which is on the western part of Odenwald forest, overlooking the Rhine valley, one of the warmest areas in Germany, zone 8a, with hot and dry summer. In city landscaping of Weinheim from public green spaces to median strip, roundabouts and sidewalk perennial plantings are noticeable.

Hermannshof gardens are older than 200 years but the main concept of turning Hermannshof into a public experimental garden, coming from Professor Richard Hansen in the late 1970s. It would be a center for plants research and education along with mandate to explore the design methods of perennial planting in public areas and later on Urs Walser developed planting plans based on the concept of grouping perennial plants by common habitat and growing conditions, Every plant habitat presents diverse groupings of intermingled combinations to achieve a highly naturalistic effect.

Based on the article of Tony Spencer (*www.thenewperennialist.com),* "In terms of perennial planting design, the garden is experimenting with two signature methods" The first was developed by director Cassian Schmidt to create gardens like their mixed prairie meadow in 2001."

Figure 1.19

Figure 1.20

Hermannshof: The Mixed Prairie Planting Method

- Set out feature perennials and grasses based on planting theme
- Fill in all gaps using a loose matrix of secondary theme plants scattered in a random pattern
- Allow generous space between plants
- Mulch with lava stone to minimize weeding and self-seeding
- Water to establish only during first year
- Allow plants to stand over winter
- Use strimmer or mulch-mower to cut back the planting in spring
- Loosely rake leaf litter together and burn off or remove

All these plants prefer moderately nutrient-poor, xeric conditions. In fact, the prairie concept was developed to find a sustainable planting solution for similar dry conditions found in central Europe. By testing it out at Hermannshof, they can easily adapt the approach to flourish in tough urban growing conditions in Germany. "(Tony Spencer 2014)

Planting strategy: Planting by sociability and random planting

Figure 1.21

Figure 1.22

1.4 Concept of random perennial mixture

In times of limited public funding the concept of mixed perennial planting is a reasonable way nevertheless to provide public green spaces as an alternative to costlier approaches with intricate planting plans or rather seasonal bedding. (Kircher 2000)

1.4.1 Definition of mixed planting

Based on the definition of Wolfgang Borchardt 2006, "*Mixed planting is planting of an area with variety of species and series of perennials or flowering plant with different sociability, in its simplest way without predefinition of surface structure, arrangement or planting site. There are not any detailed planting plan or measurement and species showing various striking aspects, forms, heights and propagation strategies complement each other to form a self-regulating system. With this model the survival of the general mixed planting model is more important than survival of the individual plants. Every individual sites with its own condition result in different competitive situation, therefore there are many possibilities for introducing structure such as dominant visual elements, theme plants(Leitstauden), core block planting, plantings can be created according to levels of sociability or in sequence."* (Borchardt 2006, Messer 2008)

1.4.2 Main requirements of mixed plantings

According to Borchardt (1998) mixed planting are comprised of many different species and based on it a "good mixed planting is a complex composition of different proven species with manifold interrelationships" (Borchardt 1998). To guarantee a sustainable approach and visually pleasing two main items need to be considered:

A- Appealing effects during the entire year duo to flowering periods and structure of the plants during the winter.

B- Produce layer effect by concentrating on plants form of growth. By making use of long-lived and short-lived species, which wander by self-seeding, the survival of the planting and form of self-regulating system will be ensured. The degree of competition among species determined by site conditions results in the aspects known from natural plant societies which enhance the visual interest and structure. (Borchardt 2005, Messer 2008)

However, in planting mixture plant species should be selected and arranged considering following criteria (Messer 2008):

- Choice of suitable site/habitat conforming (Hansen &Stahl, 1993)
- Thematic focus of the planting (i.e. color contrast)
- Growth rhythm (short-term dynamics, annual aspects, height in various seasons, long-term dynamics)
- Life expectancy of the plants (biennials, short-and long-lived perennials)
- Plant sociability (according to Hansen & Stahl, 1993)
- Reproduction and rate of propagation
- Population biological strategies (runners, rhizomes) (Grime, Hodgson & Hunt, 1986)
- Aesthetic criteria (layering, color combinations, texture)

1.4.3 Classification of perennials

Wolfgang Borchardt classified perennials into the structure types listed in Table 1 (in the following page). This table illustrates selection of the species to be used in a planting mixture and according to" Recommended proportion of plants" estimates the relative numbers. Generally, more than 50% of the total number of plants should be ground cover and other plants will give structure to the planting mixture. It is important to define appropriate numbers of plants in order to optimize plant competition, obtain rapid grow ground cover and achieve the optimal aesthetic effect and the planning of this mixture should be done by a person who has certain knowledge of botany to create a list of plants and their numbers including the species , varieties and names.

Category	Definition	Recommended proportion
Dominant species: structure plants, framework plants	Forming the structural framework of the planting, e.g. grasses (*Miscanthus sinensis, Cortaderia selloana), large-leaved perennials (e.g. Rodgersia) or upright plants (e.g. Veronica longifolia); mainly C-, C-S or S- strategies*	5-15%
Companion plants	Recurring, stabilizing elements (e.g. *Salvia nemorosa, Hemerocallis lilioasphodelus*) which define the visual character of the planting and emphasize the structure plants. Long lived plants; mainly C-, C-S or S-strategies	30-40%
Ground cover plants	Usually small perennials of up to 30 cm height which must be used in larger numbers, usually as a carpet between gaps and plants of the first two categories, i.e. *Geranium x cantabrigense, Omphalodes verna, Waldsteinia geoides*; mainly C-, C-S or S- strategies	≥ 50%
Filler plants	Short lived plants, responsible for a quick cover, and visual display in the first one to three years. Quick in growth and spreading generatively, but weak in competition, declining whilst substituted by the dominant, companion and ground cover plants (e.g. *Linum perenne, Aquilegia canadensis, Digitalis purpurea*); R-, R-S or C-R- strategies	5-10%
Scattered plants	Plants with a short growth period that do not require much space. However, these are very showy and dominant when in bloom, such as flowering bulbs (e.g. *Allium sphaerocephalon, Anemone blanda, Narcissus* 'Hawera') or very slim perennials (e.g. *Codonopsis clematidea, Campanula persicifolia)*	Added additionally in great amounts: 20-50 bulbs per sqm

Table 1: Classification of perennials (Borchardt 1998, Evert 2005, supplemented by Fenzl & Kircher 2009, Messer 2008

1.4.4 'Silbersommer' as a successful example

Perhaps 'Silbersommer' (silver summer) is the most well-known perennial mix and the most widespread planting mixture , a concept of 36 taxa since 1999, the first of what may well be several mixed perennial planting 'formulas' to be developed by union of German Perennial Nurseries Association (BdS). It aims to provide a long season of color and interest with naturalistic aesthetics, relying on flowers, leaf shape, color, texture and overall plant form.

'Silbersommer' is broken down into four categories based on aesthetic and practical criteria:

- Solitary perennials-grasses such as Festuca mairei and architectural perennial like Verbascum bombycifenum (10% of selection)
- Group perennials-species that form clumps, for example Knautia macedonica and Achillea filipendulina (40-50%)
- Ground cover-low carpeters such as Thymus pulegioides.
- Scattered plants-i.e. bulbs for spring interest, Crocus, Muscari and tulipa species (Schmidt 2000)

'Silbersommer' mixture has been planted at 13 different sites with different climatic conditions in Germany and Switzerland. Those sites in Germany are the Anhalt University of Applied Sciences in Bernburg, the University of Applied Sciences in Erfurt and Osnabrück, the Bavarian institute for viticulture and horticulture (LWG) in Veitshöchheim, the Hermanshof display garden in Weinheim, the state institute for agriculture and horticulture (LLG) in Quedlinburg-Dittfurt and some public green areas in cities such as Erfurt, Würzburg and Weimar, Those sites in Switzerland are some traffic islands and urban areas in city of Zürich and in the experimental sites of Wädenswil university of applied sciences. (Messer 2008)

Figure 1.23: Silbersommer- Wädenswil

Figure 1.24

1.4.5 Research on perennial mixtures in academic places

Research on mixed planting with the main concentration on perennials started more than 70 years ago in the University of Wisconsin, USA. From 1934 to 1957 at various time intervals, prairie meadows were tested under the supervision of Aldo Leopold and then John Curtis (Wasowski 2002). Later on, Ray Schulenberg continued the assessment of prairie plant mixtures in Illinois, USA and he was one of the first people who arranged indigenous plants based on the ecological and habitat characteristic as well as considering the aesthetic aspects (Schmidt 2006).

The phrase 'mixed herbaceous perennial planting' formally applied for the first time in 1994 by Walter Kolb and Wolfram Kircher of the institute for viticulture and horticulture in Veitshöchheim, Germany. From 1993 until 2001 in this institute they were trying to develop planting mixtures for different locations with a simplified version which can be applicable by inexperienced workers with limited botanical knowledge about perennial plantings. (Kircher 2000, Messer 2008)

In addition to the mentioned institutes, the assessment and optimization of perennial mixture with promotional 'trade names' has been done and continued since the end of 1990's by these institutes:

- Viewing and sighting garden Hermannshof, Weinheim by Schmidt.
- Institute of Horticulture / University of applied sciences, Erfurt by Pacalei and Borchardt.
- Zurich University of Applied Sciences / Institute of Environment and Natural Resources, Wädenswil, Switzerland by Tausendpfund and Heinrich.

Until now these institutes with Anhalt university of applies sciences in Bernburg published more than 50 different recommended plant mixtures. (Kircher, Messer)

1.4.6 Naturalistic appearance

According to Robinson 1898, the concept of mixed planting was originally applied to so-called natural planting. It is possible to have two different approaches to the naturalistic point of view in planting mixture, one perspective is aesthetic aspects and another one is survival elements. So when species and variety are selected according to their habitat, competitiveness, flowering, height and reproductive behavior, it will be a natural approach based on their ecological sound and competitive balance considering survival aspects and when the position of every plant is not predetermined in a planting plan, but determined by chance it will give a natural aesthetic effects.

Ideally, based on naturalistic approach planting mixture will form a self-regulating system with a dynamic model, giving priority to survival of the entire mixed planting rather than individual plants. (Kircher, Messer)

1.4.7 Bernburg perennial mixture

Experiments to create suitable perennial mixtures as well as establishing and maintaining methods are started and carried out by Prof.Kircher since 1999 at Anhalt University of Applied Sciences in Bernburg. He created an independent project with herbaceous perennial plantings in this dry region that provides an annual precipitation of only 470mm in average. The trials were supported by the German Federal Ministry for Education and Research (BMBF), the German Perennial Nurseries Association (BdS), and the German Research Foundation (DFG).


Figure 1.25, 1.26: Perennial planting research project at Anhalt University,

Till 2010 around 30 mixtures have been developed; fifteen have been optimized on the basis of knowledge and assessments gained in the project and are now published as recommendations in: (http://www.prof-kircher.de; Fenzl & Kircher, 2009). Methods and results from the assessments are recorded by Messer 2008, who elaborated many aspects of the research project in his PHD-Thesis at the University of Sheffield, supervised by Dr. Nigel Dunnett and Prof. Kircher.

1.5 Aims and Objectives

1.5.1 Find applicable pattern for perennial mixture in visual and economic aspects

One of the main aims of perennial mixture project is finding applicable patterns which are useable in public green spaces considering main involved aspects such as economic and aesthetic issues in order to develop affordable perennial mixes which combine attractiveness with low maintenance.

Regarding economic factors, the planning of diverse and rich perennial plantings can be time consuming, so in order to have better efficiency, especially in planning process, the idea of randomly perennial mixtures is created to step forward and introduce already tested attractive combinations. Nowadays in times of limited public funding the concept of mixed perennial planting is a reasonable way to provide public green spaces as an alternative to costlier approaches with complicated planting plans or seasonal bedding.

Typical sites as green space in urban and public areas are large parks and traffic areas such as traffic islands, pedestrian pathways, roundabouts and roadsides which the cost of making a planting plan for them is prohibitively high, so that random planting of mixed perennials is a possible alternative way (Kircher, Messer)

Regarding maintenance for perennial mixtures, the main concept is create a condition to minimize maintenance by the gardener and develop a simplified version of habitat which can be practically applicable by inexperienced workers with little botanical knowledge, so one of the main targets of this project is break and disprove the stereotype about expensiveness of perennial plantings.

According economic and cost factors, in this research, this question is going to be used as the foundation of data analysis:

A- How making use of native perennials can effect on the cost of preparation and maintenance in public green spaces? (in Iran)

Aesthetic factors are inseparable part of perennial mixture project parallel to economic aspects. Perennials are capable to offer an attractive seasonally changing variety of color and form. This research aims to explain that the attractiveness and the aesthetic elements which are assessed by random people from all over the world (will be explained in "material and methods" chapter) is able to improve the mixture and help the researchers end up with most favorite mixtures recommended for public green spaces.

These questions about visual and aesthetic aspects considered as the basis of research:

A. What are the methods of visual evaluation?
B. Are there any special taste of color and theme about plantings and vegetation in different countries based on variety of culture and backgrounds?
C. How the result of aesthetic factors in the research of perennial mixture in Germany can be generated on other climatic zones and countries?

1.5.2 Prepare developable modular planting system

One of the aims of this project is creating a compatible system so that obtained results in research process can be applicable in different public green spaces regardless of form, shape and size of that area without any reduction in quality. Create a modular system, nature oriented, with acceptable proportions in experimental sites will make the simulation of the project in bigger spaces, easier.

A. Is the result of perennial mixture project can be generated in plantation sites with variety of geometric shapes and figures?

1.5.3 Provide the possibility to generate selected mixtures to other climatic zones

Creating the opportunity in order to implement the result of Germany's perennial mixture project, in other countries such as Iran is another target of this research.

Since every research project requires many repetitive time consuming experiments, the obtain results will be astonishingly valuable and repeating the same experiments with the same characteristics will be costly and in some cases unnecessary, while developed countries such as Germany, Netherland, Britain, Switzerland, … are pioneers of scientific movements and research methods in planting projects, developing countries are able to make use of their results and observations to take an effective step in expansion and improvement of their public green spaces. Although different climatic zones, cultural background and different native plants will make few changes but there are many similarities which can be used effectively to activate the perennial planting potential of other lands and regions.

This question considered as the basis of research in this section:

A. How the obtained results of perennial mixture project in Germany can be generated on other lands and regions?

2. MATERIALS and METHODS

In this part of research, the characteristics of the Bernburg perennial mixture project will be explained and the methods which were applied will be discussed.

2.1 Selection of plants and the reasons of choosing them

In order to obtain reliable results in this research, the choice of appropriate species for the site and the existing condition became one of the most important prerequisites.

In this research, the main principles of the choice of perennials are based on two criteria:

A. Appearance B. Biological features

2.1.A Appearance

In study of perennial's appearance many factors such as, color of flowers and leaves, flowering time, leaves texture, height of the plants during time periods, form of growing, structure of plants and attractive combination of them are among the main criteria for choosing them. All cases which are mentioned above are according to the entire growth cycle of the plants. One of the main challenges in analyzing the aesthetic factors of perennials is their appearance during the winter which will be discussed in this probe.

In following table these criteria with their function and purposes is summarized and outlined.

Criteria	Function	Purpose
Color of flowers and leaves	Provide the mixture with a combination of colors which has been found psychologically pleasant to human	To find harmonic color combination in the mixture based on color psychology methods
Flowering time	Provide a continual sequence of flowering by including spring and winter-flowering perennials	To highlight the process of color change in perennials mixture during the entire growth cycle
Plant's texture	Classification of textures in velvety, opaque, transparent, wavy, rough, clear, multicolor, dark,….	To introduce texture of plants besides its color as a necessary element to achieve aesthetically pleasant results in the mixture
Structure and height of the plant during time periods	Making use of plants with different heights and different plants of the same height in single planting	To find out how different form, height and structure of plants can create an attractive mixture with more natural effect
Form of growing	Provide mixture with plants which can fill the free spaces between each other by variety in form of growing	To show how much distance required between perennials based on their growth form and how it can contribute to the ornamental effect during the entire vegetation period
Attractive combination of plants	Provide the mixture with visual rhythm and natural effect	To keep the physical quality of the mixture attractive during the whole year including winter

Table 2

2.1.B Biological features

According to Zander 2002 and Messer 2008, in selecting appropriate species, some biological features are among the affecting factors such as:

A. Propagation and dissemination strategies (Grime, Hodgson, Hunt,1986), in order to introduce dynamic growth to form a stable plant community by dividing them to perennials which produce runners or rhizomes and perennials that form tussocks.
B. Habitat
C. Life span, to speed up obtaining the aesthetic quality, primarily in the first year, by creating short and long life span groups.
D. Competition, which depends on many factors beyond the ability of planners. The competition can be minimized by proper selection of plants with equal propagation strength and the only way to obtain desirable result in a long term is exact observation and repetitive examinations.
E. Plants with storage organs, in order to survive through extreme sites such as public areas and enlist of early flowering before other perennials for pleasant appearance in the spring. These plants include Bulbs (e.g. Anemone blanda), Tubers (e.g. Eranthis hyemalis) and Succulents (e.g. Sedum telephium).

2.2 Experimental site

The Bernburg perennial mixture project was established in 1998-99 in the Campus of Anhalt University in Bernburg-Strenzfeld and it was expanded in 1999-2000 along parking lots until building of Biotechnikum on the Anhalt University in Bernburg. In different time periods, from 2001 and later on, more experimental sites were made in other locations with similar strategies to test the planting mixtures and provide comparable conditions but the most important location in this study was the city of Bernburg with the largest number of experimental plots.

Bernburg (Saale) located in the Germany federal state of Saxony-Anhalt, capital of Salzlandkreis district. The town center is situated in the fertile Magdeburg Börde lowland on the Saale River with the elevation of 85m above sea levels and an annual 490mm rainfall. City of Bernburg is considered as continental climate and categorized as very dry place with low precipitation. (Messer 2008)

In following pages there are some climate diagrams which show Max, Min and average temperature, rainfall and rain days, snowfall and snow days, wind speed and sun hours and sun days of Bernburg from 2014 until end of September of 2016.

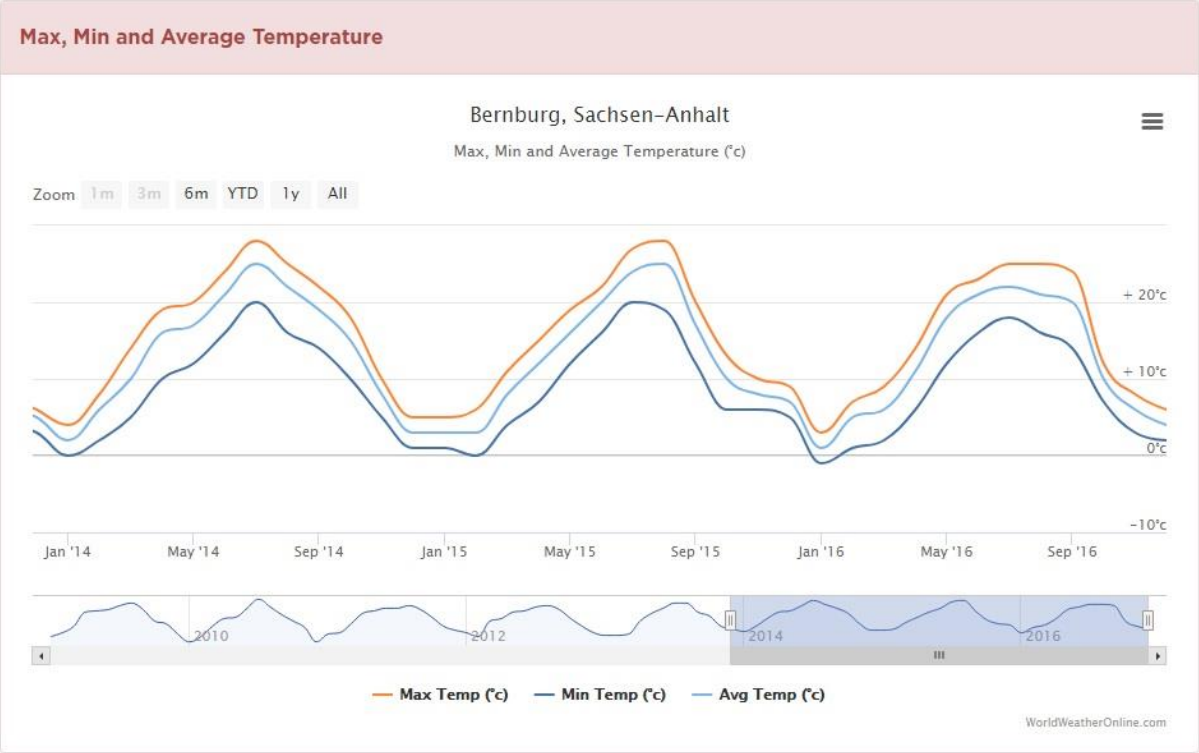


Diagram 1

Diagram 2

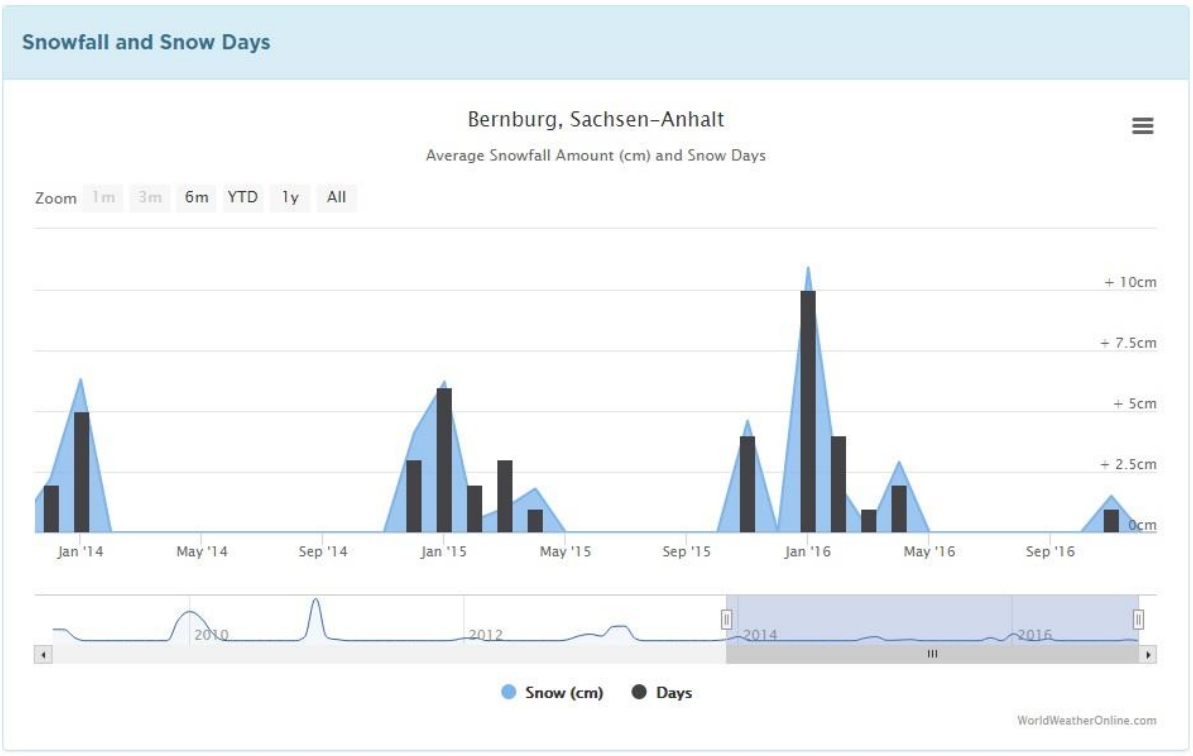


Diagram 3

Diagram 4

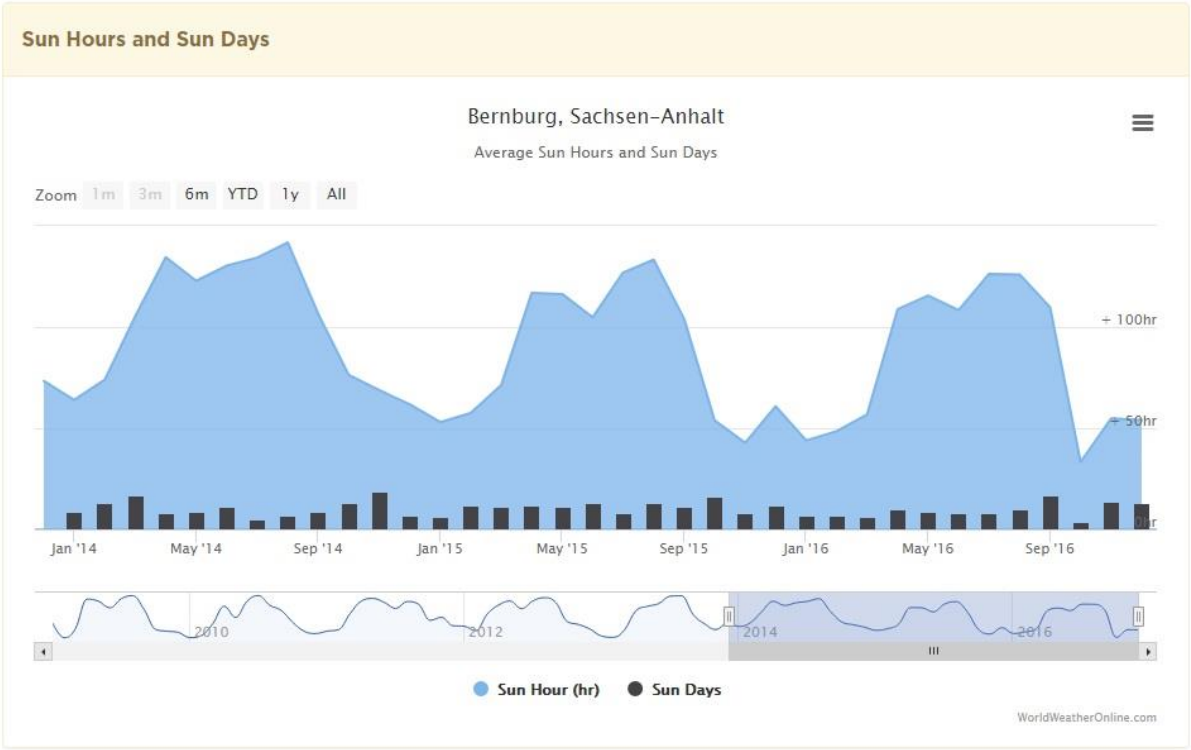


Diagram 5

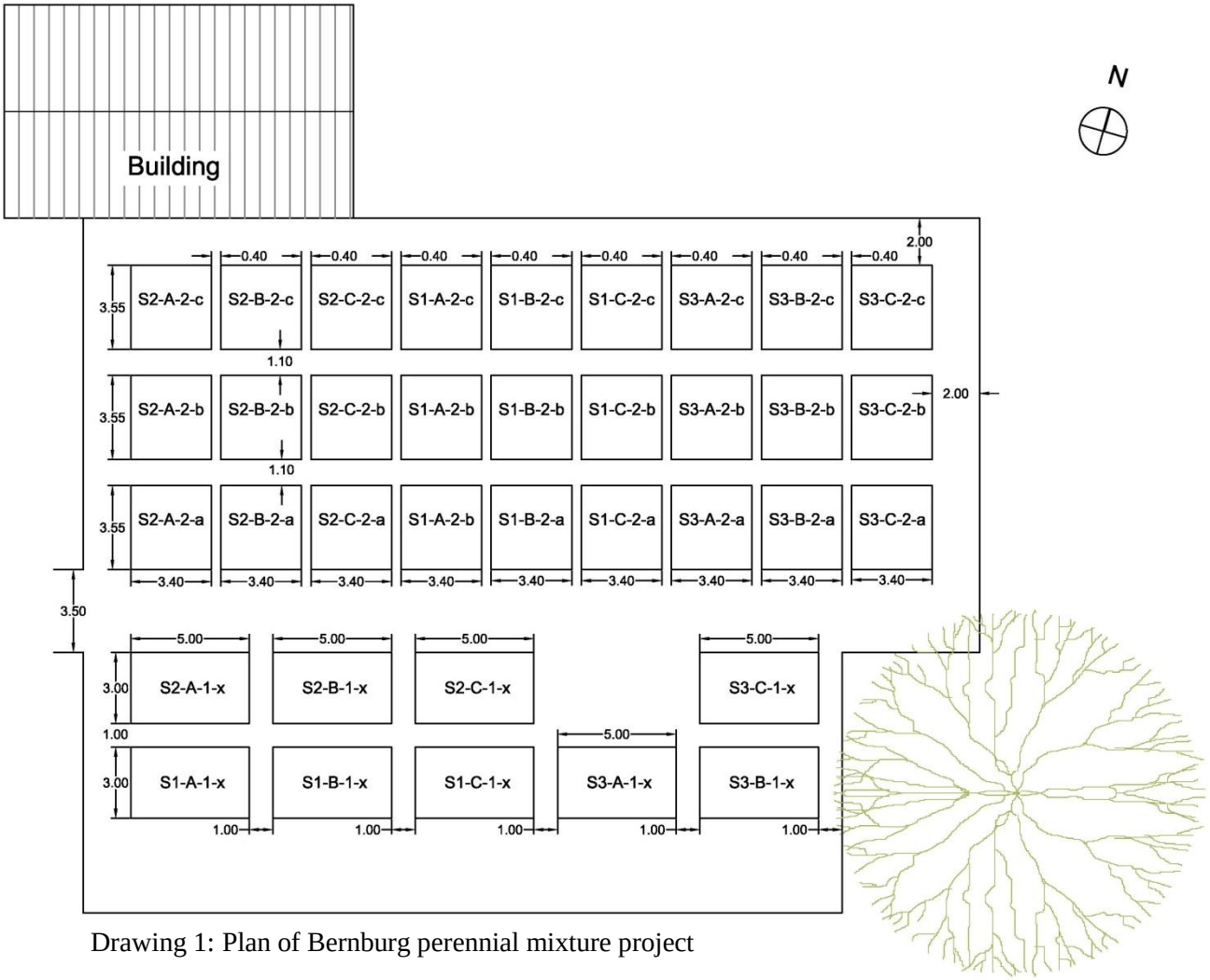
In This research project, during the experimental period, from 1999 until 2016 at various time intervals, all data including times of maintenance, irrigation, development and aesthetic aspects were recorded. Research area in this project is divided to many different plots based on research characteristics such as soil quality, perennial mixture, irrigation pattern, and being in open space or covered area.

In following page there is a layout plan of Bernburg perennial mixture project with location of different plots and their abbreviated names.

Name of each plot indicates 4 factors: (For example, S1-A-2-b)

Sx (e.g. S1,S2,S3)	A, B, C	1,2	a, b, c, x
Soil type	Type of perennial mixture	Open and covered area	Irrigation pattern

Table 3



Drawing 1: Plan of Bernburg perennial mixture project

Figure 2.1: Satellite image of Bernburg perennial mixture project

2.3 Factor A: Perennial mixture

Bernburg perennial mixture project in 2015-16 included 36 plots and each plot contained 10 to 18 different perennial species. In fact each plot had at least 1 experimental factor different from other plots. In general in this project 3 perennial mixtures had been used:

Mixture "A": Flower Haze (Blütenschleier)

Mixture "B": Prairie Summer (Präriesommer)

Mixture "C": Moist Site (feuchter Standort)

2.3.1 Mixture "A" (Flower Haze): in 12 sqm and 15 sqm plots.

Species		No. in 12 sqm	No. in 15 sqm
Dominant Perennials			
Ca.ac.	Calamagrostis x acutiflora 'Overdam'	6	7
Companion perennials			
Ac.cl.	Achillea clypeolata 'Schwellenburg'	12	15
As.no	Aster novae-angliae 'Purple Dom'	12	15
Pa.la.	Papaver lateritium 'Plena'	12	15
Sa.no	Salvia nemorosa 'Mainacht'	12	15
Filling perennials			
Li.pu.	Linaria purpurea	7	9
Ground covering perennials			
An.tr.	Anaphalis triplinervis 'Silberregen'	7	9
As.er.	Aster ericoides 'Snowflurry'	12	15
Eu.cy.	Euphorbia cyparissias 'Fens Ruby'	7	9
Gy.re.	Gypsophila repens 'Pink Star'	12	15

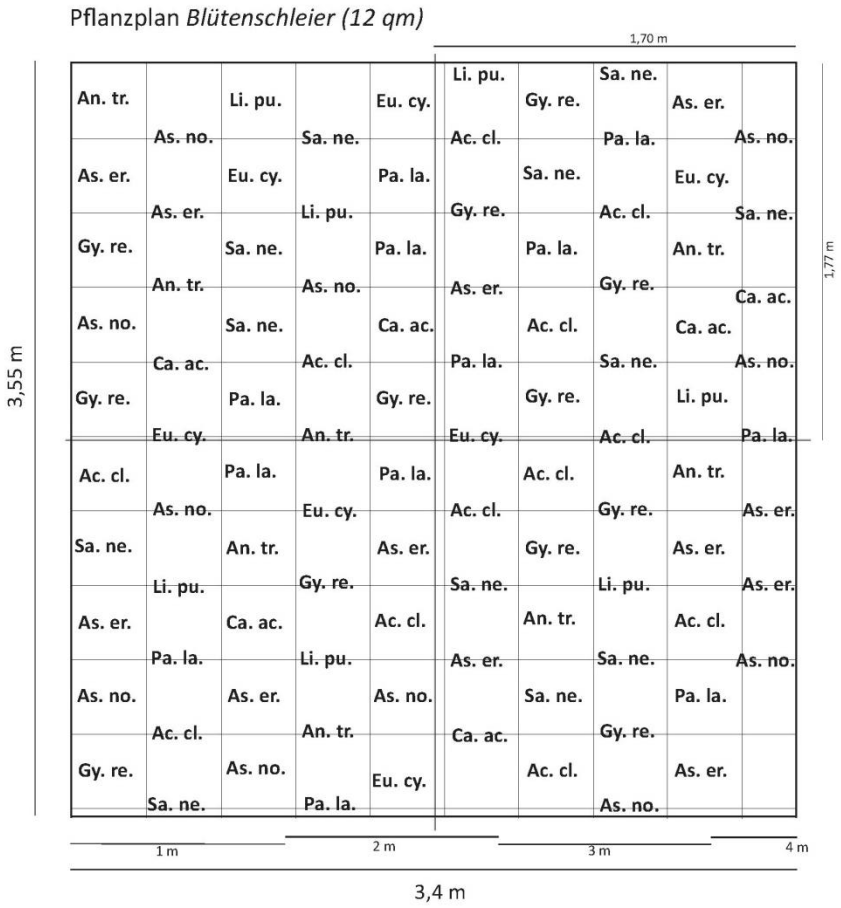
Table 4

Mixture "A" (Flower Haze) is very presentable mixture with frequently changing visual character while the dominant colors are blue and yellow. This mixture is optimal for open, sunny spaces and dry, permeable crushed gravel-substrates. (Kircher 2007)

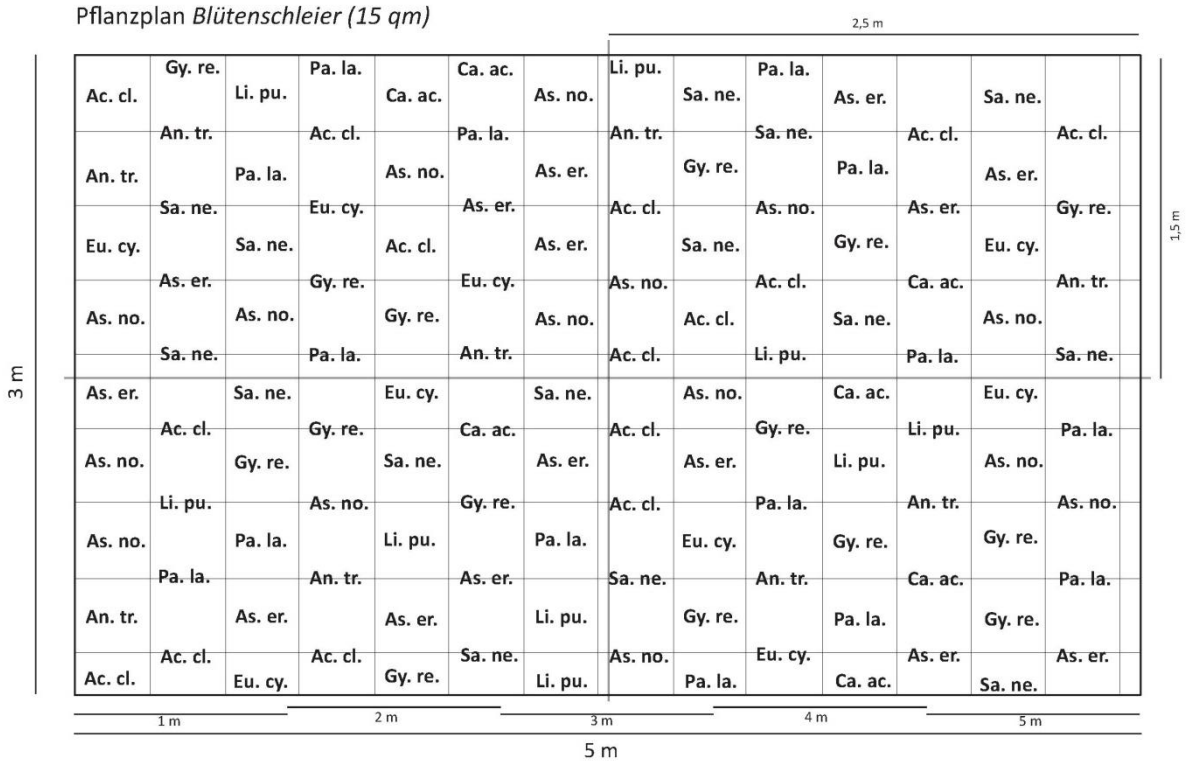
The following table explain perennial of this mixture with more physical characteristics.

Species	Height (cm)	Spread (cm)	Dominant color	Characteristics
Dominant Perennials				
Calamagrostis x acutiflora	60	90	Green,Yellow	Taut grass with a discreet white-brown foliage
Companion perennials				
Achillea clypeolata	40	60	Grey silver, Light yellow	Lemon yellow flowering, ornamental seeds in winter
Aster novae-angliae	50	40	Blue-Violet, Green,Yellow	Low, compact shape of the pirate Aster
Papaver lateritium	30	25	Salmon pink, Green	Low, perennial poppy, sprouting in autumn, draws in summer
Salvia nemorosa	40	40	Violet-Blue, Green	Blue violet early summer blooming
Filling perennials				
Linaria purpurea	60	40	Pink, Green	Fit itself in empty spaces
Ground covering				
Anaphalis triplinervis	40	40	Silver White, Dark Green	Gray-green foliage, white "straw flowers" with good winter effect
Aster ericoides	50	45	White	Form flat field, white blooming in October
Euphorbia cyparissias	15-30	10-15	Bright yellow ,Green	Dark red shoots, spreading through subterranean branches
Gypsophila repens	50	60	Pink, Light Green	Loose pink flower in midsummer

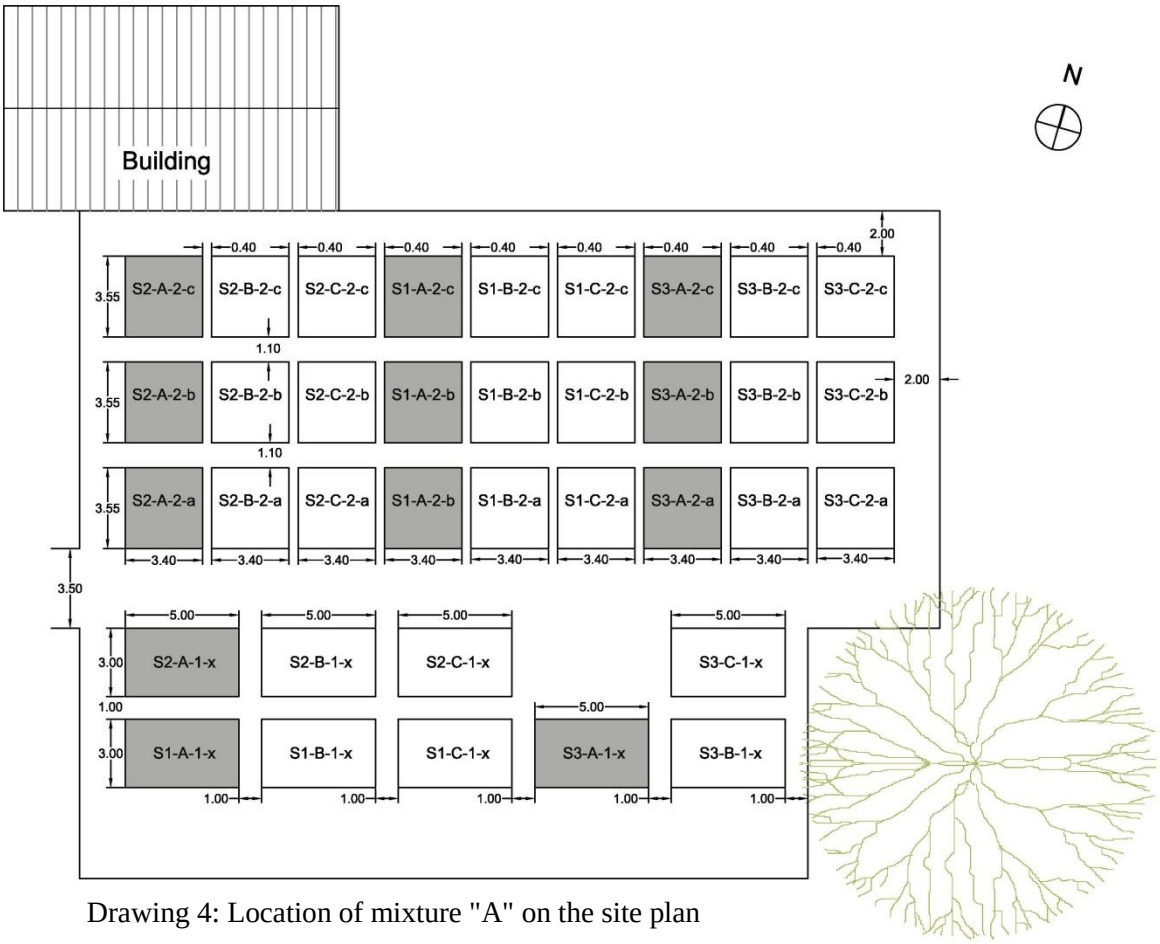
Table 5



Drawing 2: Planning of planting mixture "A", Flower Haze - 12 sqm



Drawing 3: Planning of planting mixture "A", Flower Haze - 15 sqm



Drawing 4: Location of mixture "A" on the site plan

Figure 2.2: Mixture "A" plots' signs in the Bernburg's research site

2.3.2 Mixture "B" (Prairie Summer): in 12 sqm and 15 sqm plots.

Species		No. in 12 sqm	No. in 15 sqm
Dominant Perennials			
Ag.fo.	Agastache foeniculum 'Blue Fortune'	2	2
As.er.	Aster ericoides 'Pink Star'	2	2
Ba.au.	Baptisia australis	2	2
So.ca.	Solidago caesia	2	2
Pa.vi.	Panicum virgatum 'Hänse Herms'	2	3
Companion perennials			
Ec.pa.	Echinacea pallida	6	7
Ec.pu.	Echinacea purpurea	9	11
Li.sp.	Liatris spicata 'Floristan Violett'	8	9
Mo.fi.	Monarda fistulosa var.menthifolia	5	6
Pa.in.	Parthenium integrifolium	2	2
Pe.di	Penstemon digitalis 'Huskers Red'	6	7
Tr.oh.	Tradescantia ohiensis	10	12
Filling perennials			
Ve.bo.	Verbena bonariensis	4	4
Ga.li.	Gaura lindheimeri	2	2
Ground covering perennials			
Py.te.	Pycnanthemum tenuifolium	18	22
As.di.	Aster divaricatus	13	15
Ar.lu.	Artemisia ludoviciana 'Silver Queen'	2	2
Oe.pi.	Oenothera pilosella	6	7

Table 6

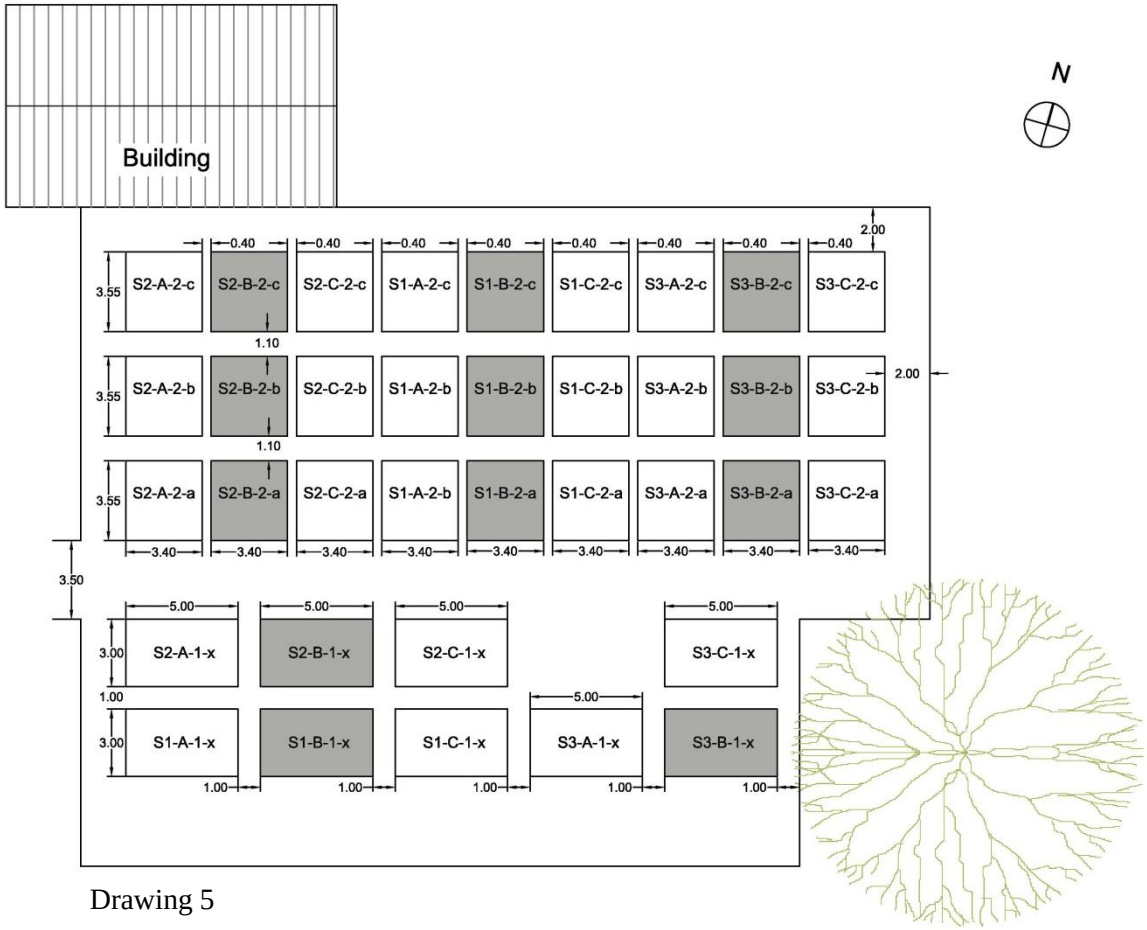
Mixture "B" (Summer Prairie) is suitable for moderately dry to fresh sites, sunny, permeable, with sufficient clay content. Dominant colors in this mixture are pink, purple and white with the emphasis of blue and violet.

Species	Height (cm)	Spread (cm)	Dominant color	Characteristics
Dominant Perennials				
Agastache foeniculum	60-80	40-60	Violet-blue	Blue blossoms, ornamental seeds, vertical structure
Aster ericoides	50-90	50	Light pink	Pleasant Fragrant , very long flowering
Baptisia australis	100	60	Bright blue, Grey-Green	Beautiful seeds, solitaire, slow developer
Solidago caesia	80	60	Yellow	Elegant, arched growth form at flowering, clump forming
Panicum virgatum	60-80	80	brownish-red	Solitaire, ornamental seeds, striking autumn color, slow developer
Companion perennials				
Echinacea pallida	70-80	40-50	Pink	Early-summer blooming with tradescantia and Monarda, ornamental seeds
Echinacea purpurea	70-80	40-50	dark crimson	Summer blooming with liatris, ornamental seeds
Liatris spicata	30-80	20-25	Violet pink	Summer blooming, vertical structure, slow developer
Monarda fistulosa var.menthifolia	40-80	50-70	purple	Early summer, purple flowers, globular seeds, short-lived
Parthenium integrifolium	80	50-60	White	White translucent cones, long flowering period, grazing seeds, lush foliage
Penstemon digitalis 'Huskers Red'	80	35-40	White	Winter greyish rosettes, reddish sprout, autumn coloring, early summer blooms
Tradescantia ohiensis	30-60	20-30	Bright blue	
Filling perennials				
Verbena bonariensis	60	30-40	Violet	Long-flowering, plants survive only in mild winters, but they are rich in gaps
Gaura lindheimeri	80	40	White	Compact variety, white flower, flowering until frost, often short-lived

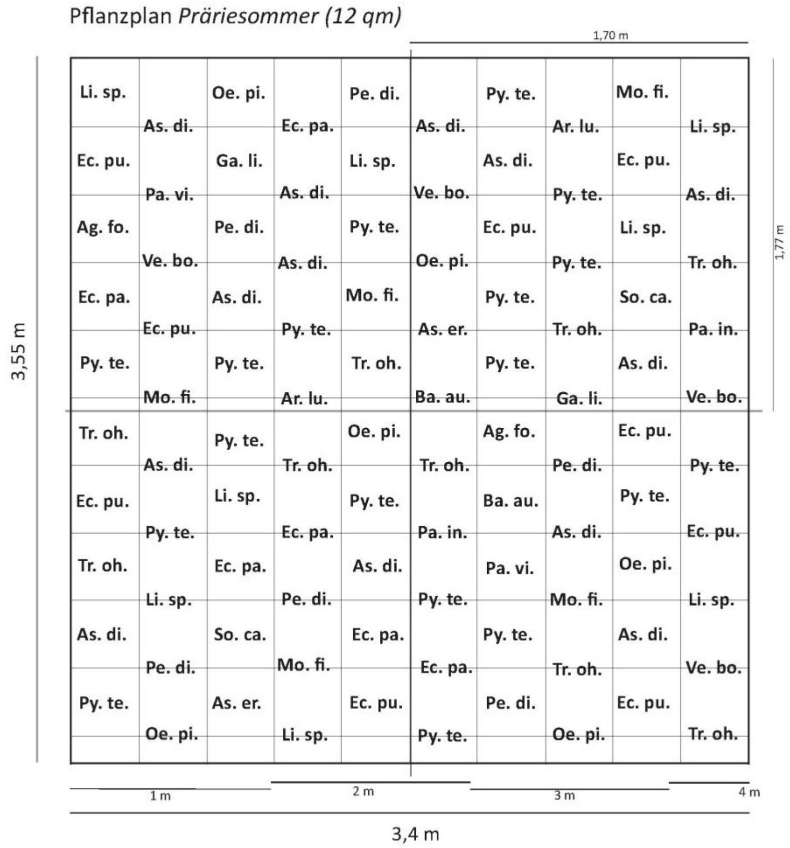
Species	Height (cm)	Spread (cm)	Dominant color	Characteristics
Ground covering				
Pycnanthemum tenuifolium	40-50	30-40	bright purple	Short rhizomes, ornamental seeds
Aster divaricatus	40	50	White	Late summer flowering, long flowering period, low, white
Artemisia ludoviciana 'Silver Queen'	50	20-30	Silver white	Clear white felt foliage, forms spurs
Oenothera pilosella	30-60	45-60	Yellow, Green, Red	Early summer bloomer, lemony yellow, winter green rosettes, short rhizomes, red autumn color

Table 7

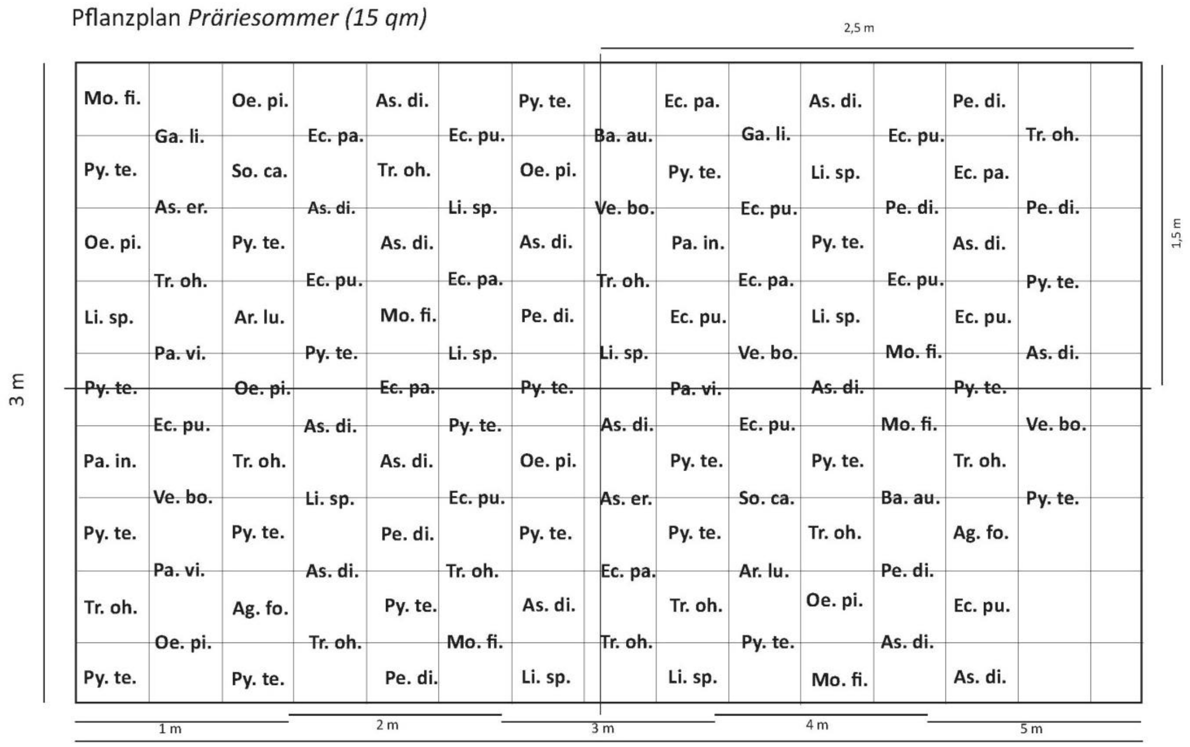
Location of mixture "B" on the site plan:



Drawing 5



Drawing 6: Planning of planting mixture "B", Summer Prairie - 12 sqm



Drawing 7: Planning of planting mixture "B", Summer Prairie - 15 sqm

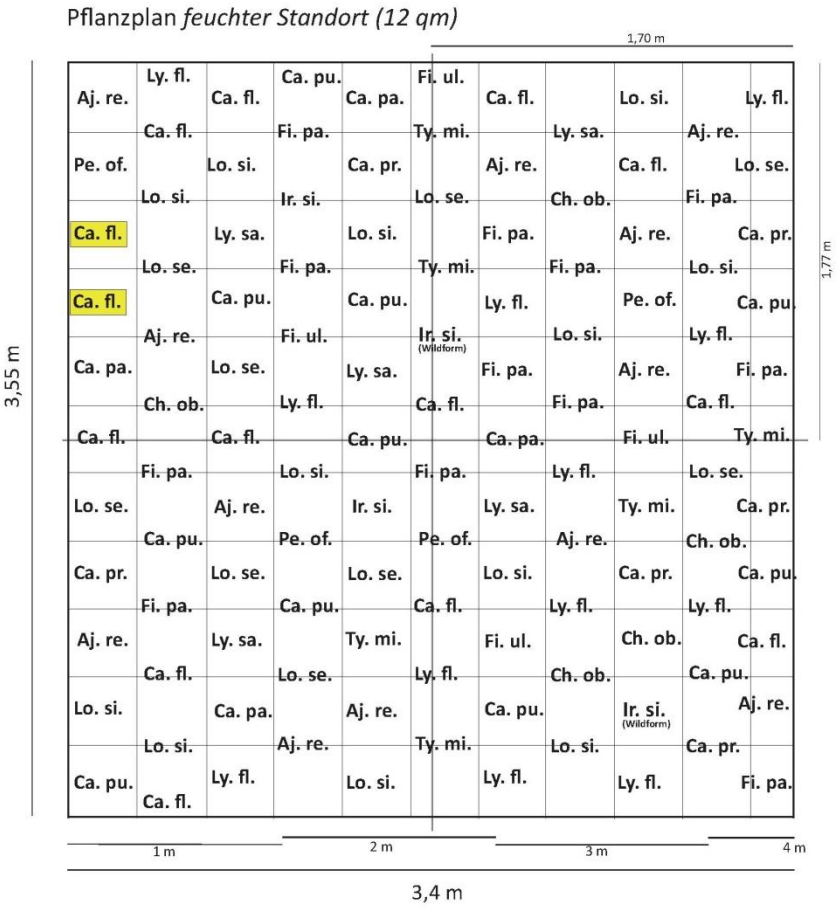
2.3.3 Mixture "C" (Moist Site): in 12 sqm and 15 sqm plots.

Species		No. in 12 sqm	No. in 15 sqm
Dominant Perennials			
Ly.sa.	Lythrum salicaria	5	6
Fi.ul.	Filipendula ulmaria 'Plena'	4	5
Ir.si.	Iris sibirica (Wildform) + 'Caesars Brother'	4	5
Companion perennials			
Ch.ob.	Chelone obliqua	5	7
Fi.pa.	Filipendula palmata 'Nana'	12	15
Pe.of.	Persicaria officinalis `Superba´	4	5
Lo.se.	Lobelia sessilifolia	9	13
Ty.mi.	Typha minima	6	8
Ca.pa.	Caltha palustris	4	5
Filling perennials			
Lo.si.	Lobelia siphilitica	12	15
Ly.fl.	Lychnis flos-cuculi	12	15
Ca.pr.	Cardamine pratensis	6	7
Ground covering perennials			
Aj.re.	Ajuga reptans 'Atropurpurea'	12	15
Ca.fl.	Carex flava	13	17
Ca.pu.	Carex pulicaris	10	11

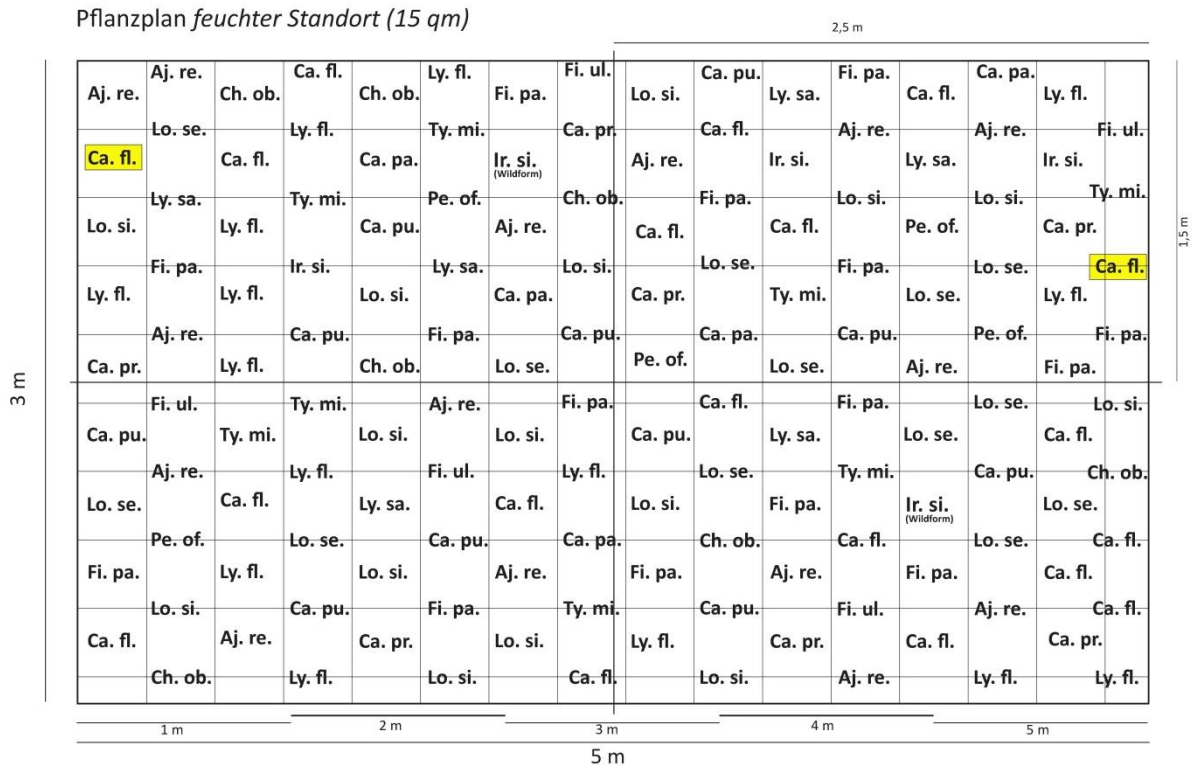
Table 8

Species	Height (cm)	Spread (cm)	Dominant color	Characteristics
Dominant Perennials				
Lythrum salicaria	60-80	30-40	dark-purple-red	Forming clonal colonies, The stems are reddish-purple or red to purple
Filipendula ulmaria 'Plena'	15-40	15-25	bright white	The flowers are processed in bouquets and white, fragrant soft accents
Iris sibirica (Wildform) + 'Caesars Brother'	60-100	40-60	Dark-violet blue	Blooming from May until June, green linear leaves
Companion perennials				
Chelone obliqua	70-80	45-50	Blue-Pink	Stiff upright, nettle-like foliage, tubular inflated flowers
Filipendula palmata 'Nana'	35		Pink	Low variety with intense pink flowers
Persicaria officinalis `Superba´	60-80	40	light pink	Blooming in June and July
Lobelia sessilifolia	50		Violet-Blue	Blooming in June and July
Typha minima	40-60	30-40	Green, brown	Dwarf Reedmace, fine grassy foliage, leaves up to 4mm in width
Caltha palustris	30-40	20-30	Yellow	Rounded leaves, golden yellow flowers
Filling perennials				
Lobelia siphilitica	60	40	Blue	Clump forming, conspicuously blue flowers, self-seeding
Lychnis flos-cuculi	40	20-30	Blue-Pink	Native perennial of damp meadows
Cardamine pratensis	40	20-30	White to Pink-Violet	Delicate spring flowering perennial for mist lawns
Ground covering				
Ajuga reptans 'Atropurpurea'	15		Blue, violet	Red-Brown foliage, metallic shine,blue flower
Carex flava	5-50	40	Yellow-green	Light green, narrow foliage grows in loose, small hollows
Carex pulicaris	10-30		Yellow, green, brown	Very delicate grass with thin stalks

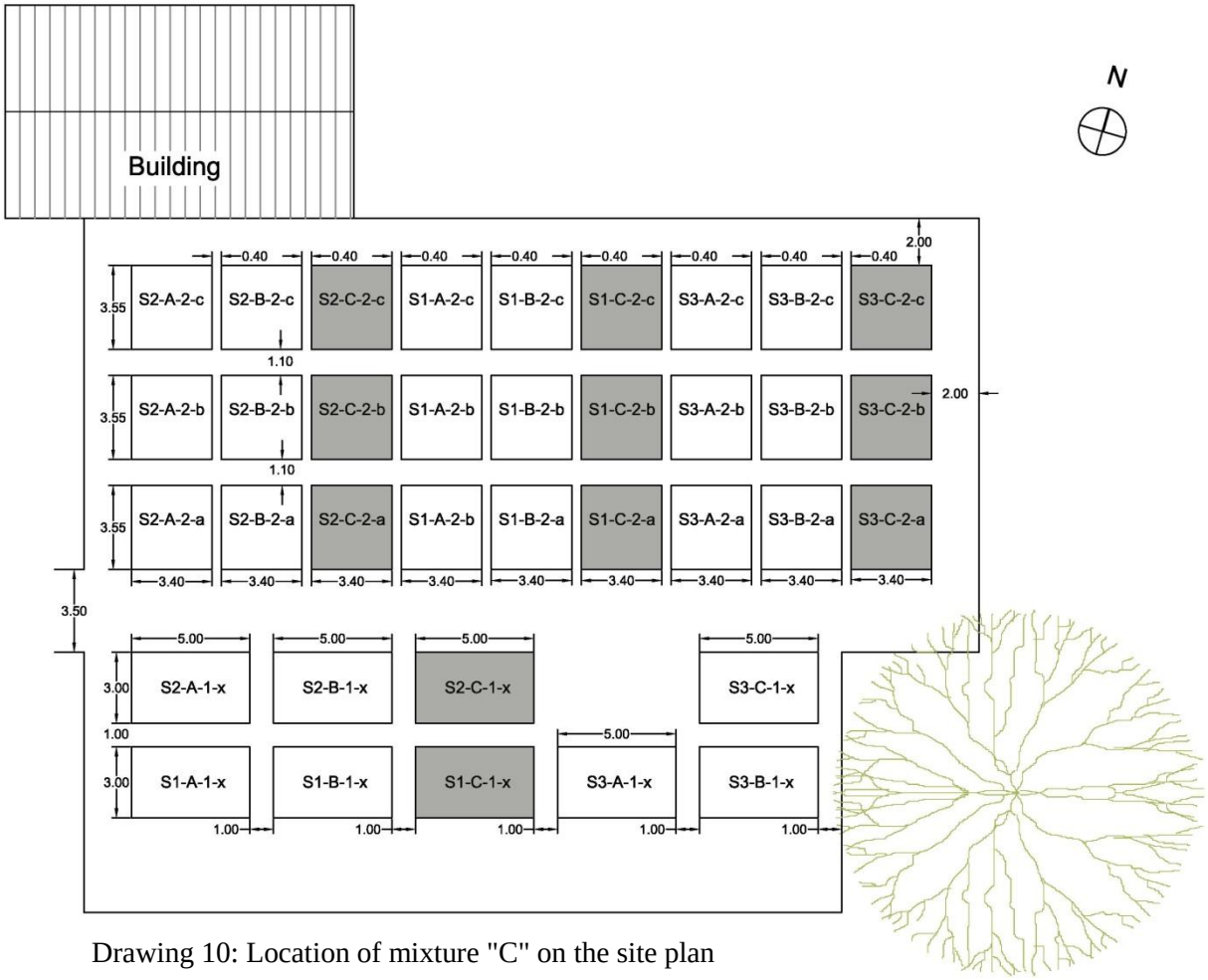
Table 9



Drawing 8: Planning of planting mixture "C", Moist Site - 12 sqm:



Drawing 9: Planning of planting mixture "C", Moist Site - 15 sqm:

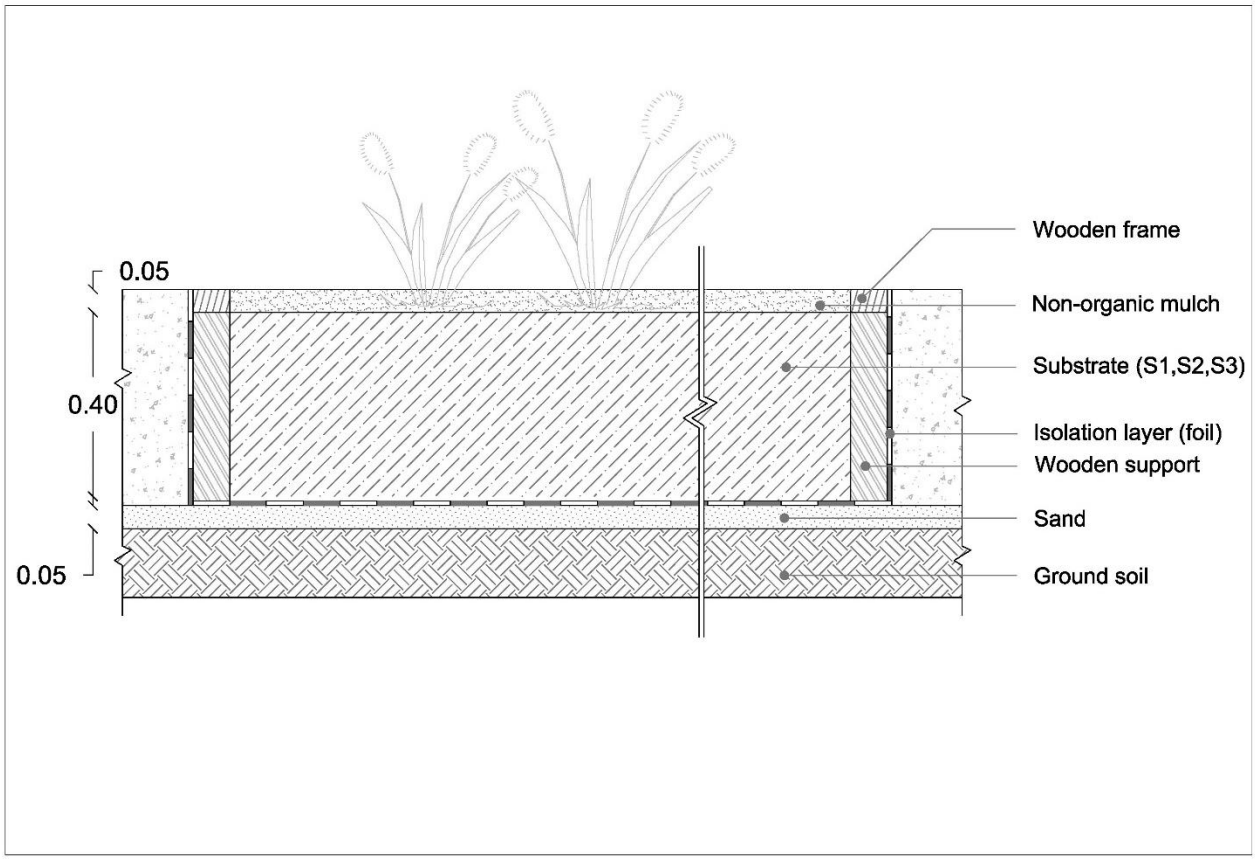


Drawing 10: Location of mixture "C" on the site plan

Figure 2.3: Mixture "C" plots' signs in the Bernburg's research site

2.4 Factor B: Soil type, sub-layers, Substrate

At the beginning for the preparation of the site, approximately 20 cm of existing soil (ground soil) was removed in order to create a flat base and reach to proper surface to start, then for roofed area the surface was covered by 5 cm sand and a layer of isolation (foil) on it to prevent any kind of influence from sub layers of the soil on experimented plots. In non-roofed area (open space) there is no isolation (foil) at the bottom. For each plot a frame had been made by foil and wooden supports (with around 40 cm depth) and filled by substrates (S1, S2, S3) related to each predefined plot. After planting process at the end of spring whole surface had been covered by 5 cm nonorganic mulch (lime-free gravel, grain size 8/16 mm).



Drawing 11: Sub-layers of each plot

The preparation process of Bernburg perennial mixture project:

Step 1- Around 20cm of the ground soil was removed to create a flat base.

Step 2- 5cm sand coverage for roofed zone on ground soil.

Step 3- Isolation layer (foil) over the sand.

Step 4- Create a foil frame with wooden supports for each plot.

Step 5- Foil frames filled by different substrates.

Step 6- Planting process

Step 7- 5cm nonorganic mulch coverage.

In this project 3 type of soil are experimented as substrates of various mixtures which are indicated by S1, S2 and S3 on their plot signs in the site:

S1- Grit (gravel)

S2- Perennial substrate

S3- Top soil

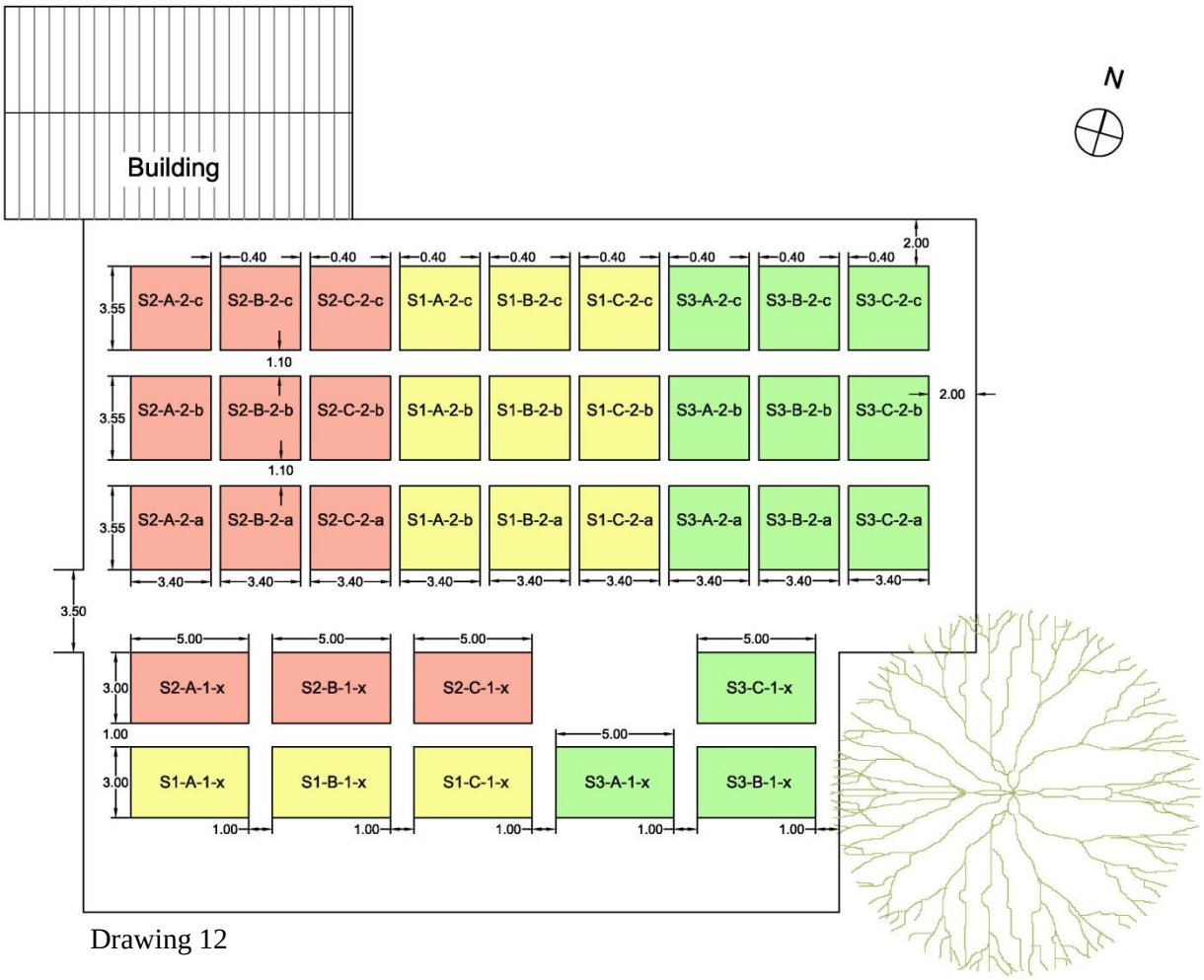
Figure 2.4: S 1- Gravel

Figure 2.5: S 2 - Perennial substrate

Figure 2.6: S 3 – Top soil

Figure 2.7: Sample soil types on research site

Soil types on site plan:



Drawing 12

S1-Gravel

S2-Perennial substrate

S3-Top soil

2.5 Irrigation pattern, covered and open area

In order to simulate different climatic zones with different rate of precipitation to determine how it effects on the behavior of plants and their appearance, this project is divided in two different spacing.

1. Close spacing (covered zone)
2. Open spacing

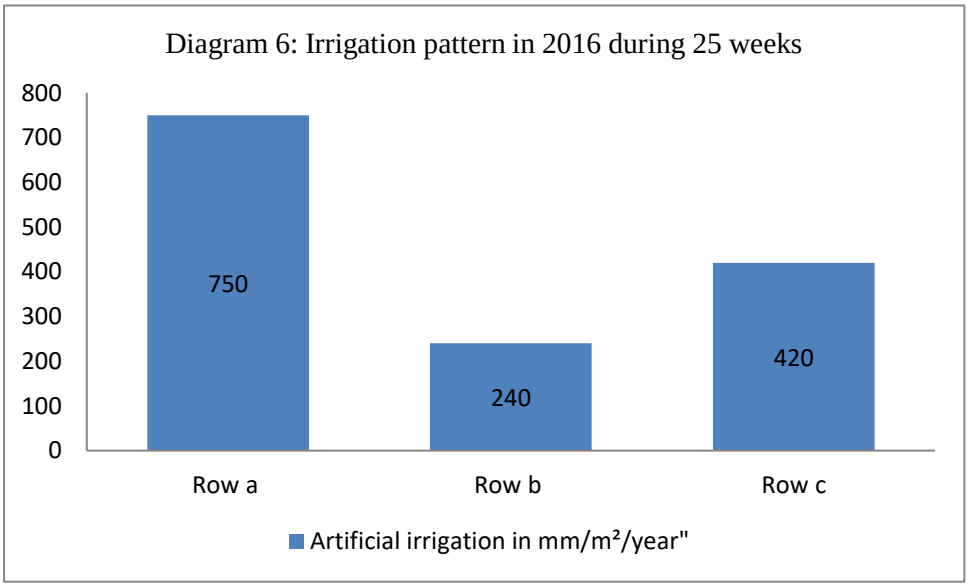
2.5.1 Close spacing (covered zone)

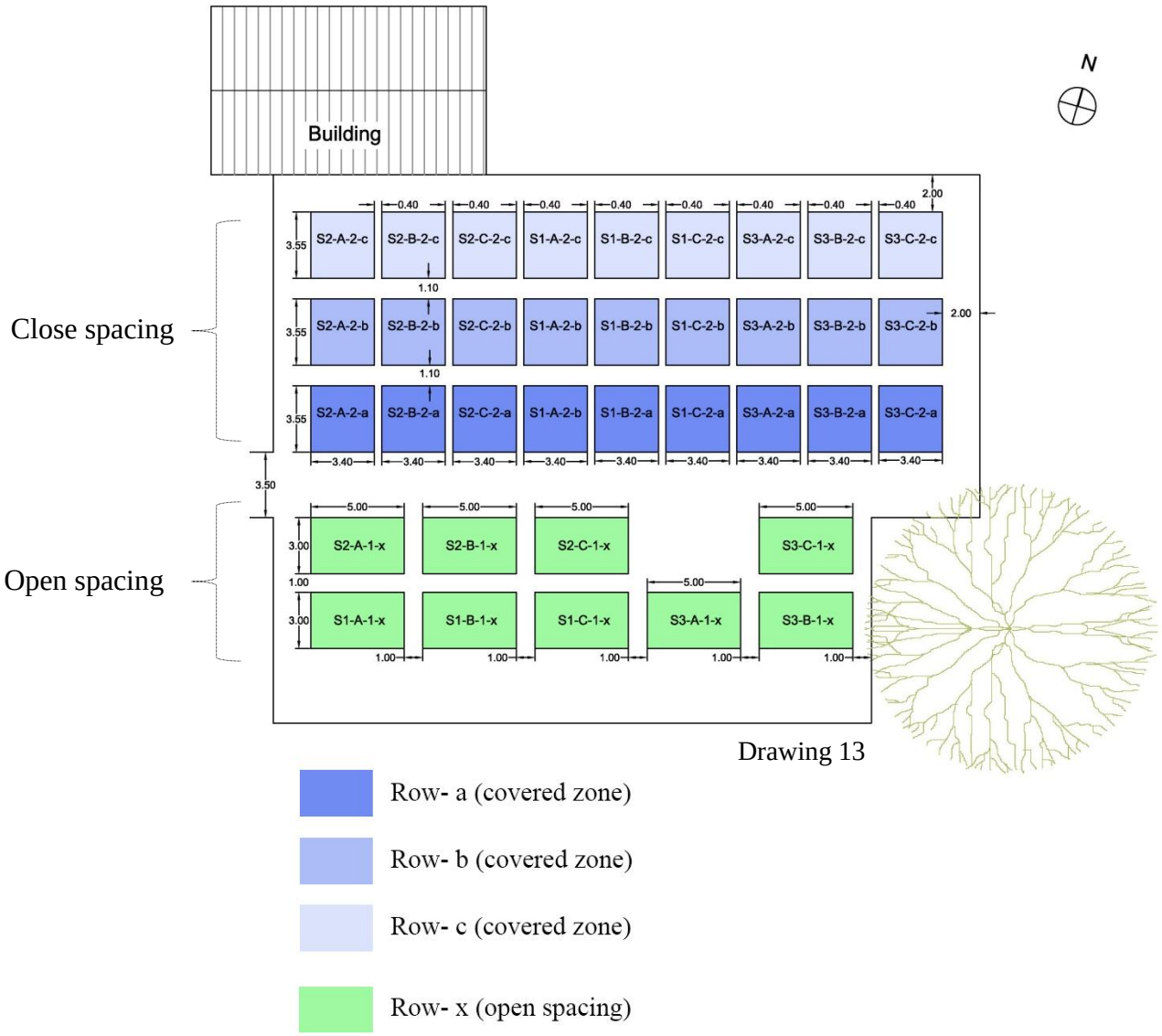
Covered zone is divided into 3 sub-groups which can be recognized by the name of each plots as " a, b and c" in the last part of their naming system. Each row of "a, b and c" has different irrigation pattern and since they are placed in closed area they are less affected by the amount of precipitation in the city of Bernburg. This area contains 27 plots and each plot is around 12 sqm (3.40 * 3.55), each row contains 9 plots with the same watering schedule which are displayed in following site plan.

2.5.2 Open spacing

Open space plots can be found on the plan by "x" in the last part of their naming system. As it mentioned before these plots are exposed to the precipitation and climatic change of Bernburg throughout the research time over the year. Open spacing includes 9 plots and each plot is 15 sqm (5.00*3.00). In open space plots there are no watering schedule and they only benefit from atmospheric precipitation.

Diagram 6: Irrigation pattern in 2016 during 25 weeks





Drawing 13

Figure 2.8: Overall view of open space and covered area plantation in research site

Figure 2.9: Recognition of spacing by plot names

2.6 Tested factors and how they were recorded

2.6.1 Visual assessment methods

There are various evaluation methods for landscape visual assessments. Planting area can be evaluated on the basis of evaluator's assessment by physical presence at the project site, computer simulations, photographs and internet survey (Scott and Canter 1997). Basically each method has its own advantages and disadvantages and it is true in the case of all methods, for example in photography method the selected scene of landscape is based on photographer interpretation (Messer 2008) so the opinion of evaluator can affected by cultural background, personal experiences, person's mental and emotional state and can be modified by different elements such as what evaluator would like to do in landscape or why they go there at all (Scott and Canter 1997).

As it mentioned already (2.1.A Appearance) there are many factors which can influence public acceptance about landscape- color combination, plants texture, structure and height, plant density and vegetation form- are important evaluation criteria.

In this research the focus for visual assessment will be on grading system by evaluators in site (year 2016) and computer aid-graphic evaluation through internet survey.

2.6.1.1 Grading system by evaluators in site

In this method different people by physical presence at the research site will give a grade to each mixture plot based on their understanding about aesthetic aspects. These include different people with different characteristics such as nationality, education, cultural background and interests. These information will be recorded monthly and the average of them will belong to that mixture in that particular month and this provide the opportunity to be able to compare these grades and understand that in public view which mixture in which particular month is most favorable or a mixture in which month of the year is in its best situation in terms of people opinion (in general point of view in addition to the aesthetic aspects, it can be understood that which substrate or which irrigation pattern will end up with most favorable result in people point of view).

In 2016 during 6 months from May to October these experiments have been done in Bernburg perennial mixture project that part of it is summarized in following pages (see all recorded data in Appendix 1).

- It is necessary to mention that people were asked to give grade to each plot based on overall impression, GE (Gesamteindruck) and detail effect, SW (Schmuckwirkung).
- In this research the result of mixture "C" (moist site) were left out because of not being site conformed which required special interpretation.

Grading method:

Grade	Overall impression	Detail effect
1	Very bad (sehr schlecht)	Very little (sehr geringe)
3	Bad (schlecht)	Little (geringe)
5	Medium (mittel)	Middle (mittlere)
7	Good (gut)	High (hohe)
9	Very good (sehr gut)	Very high (sehr hohe)

Table 10: Grading system

Samples of visual assessments by evaluators on May 2016 (for complete results see Appendix 1):

May 2016	Evaluators		J.F		A.E		D.J		M.G		Average	
Number	Mixture	Substrate	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW
S2-A-2-a	Flower Haze	Perennial substrate	9	9	6	5	9	9	7	7	7.75	7.50
S1-B-2-b	Prairie	Gravel	7	6	6	6	5	2	5	4	5.75	4.50
S3-A-2-c	Flower Haze	Top soil	7	8	7	8	6	6	7	7	6.75	7.25

Table 11

This table is presenting 3 random mixtures which were evaluated by 4 people to show visual grading method and how they were recorded.

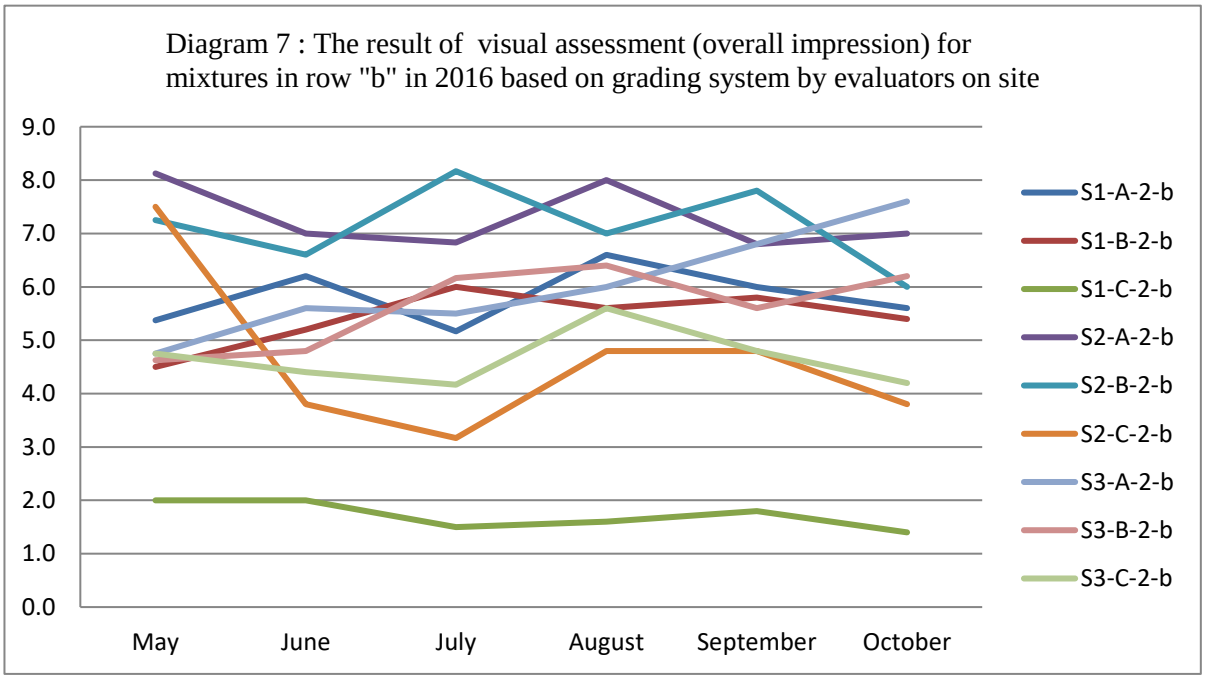
Following table is presenting obtained grades of mixture "S2-B-2-a" during 3 months in May, July and October by 4 evaluators (for complete results see Appendix 1):.

Mixture S2-B-2-a	I.B		J.F		A.E		D.J		Average	
Month	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW
May	8	6	8	7	5	5	9	5	7.50	5.75
July	9	8	8	9	5	5	9	9	7.75	7.75
October	7	6	6	6	6	6	9	9	7.00	6.75

Table 12

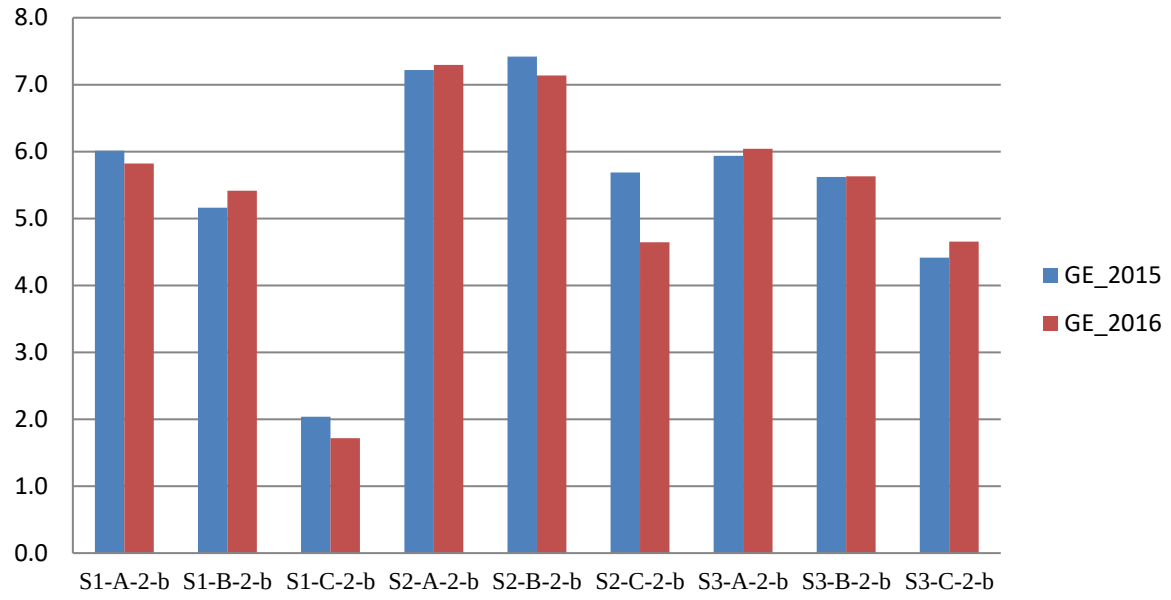
This table is presenting the grading process for one random mixture to show how during the experiment period visual aspect of one mixture can change.

According to grading system for visual assessment, in total obtained results of this 6 months can be presented in a diagram separately for each mixture, for instance the visual assessment diagram of the mixtures in row "b" has been shown here (for complete diagrams see Appendix 2):



After recording all visual data during the year, results can be compared with the achieved results in previous years so that the changes of the mixtures can be more visible and understandable over the years, for instance the visual comparison diagram of row "b" in 2015 and 2016 is presented here (for complete diagrams see Appendix 3):

Diagram 8 : Comparison of the visual results in grading system by evaluators in site between 2015 and 2016 in row "b"



The result of visual assessment method through "grading system by evaluators in site" in 2016 (for complete diagrams see Appendix 4):

Highest grade mixtures between 36 plots:

Number	Mixture	Substrate	Average grade
S2-A-2-a/b/c*	Flower haze	Perennial substrate (Sandy)	7.40
S2-B-2-a/b/c*	Prairie	Perennial substrate (Sandy)	7.30

Table 13

* According to Appendix 4, the amount of irrigation didn't effect significantly on grading results.

- Advantages of this method: The grading system is based on the real physical presence in the site and direct feeling of the space without intermediaries.
- Disadvantage of this method: The numbers of people who can attend are limited and it is difficult to involve high variety of people with different cultural and interest background.

2.6.1.2 Computer aid-graphic evaluation through internet survey

In this method which is inspired from color psychology techniques, every perennial mixture will be simulated based on their color combination in different time periods and seasons. In this way planting plan will be placed on the screen and the dominant color of each plant (flower and leaf) on that certain season will be painted in its own area. The result is an image derived from a combination of different colors and similar to a painting inspired from color of those plants on that specific season (spring and summer).

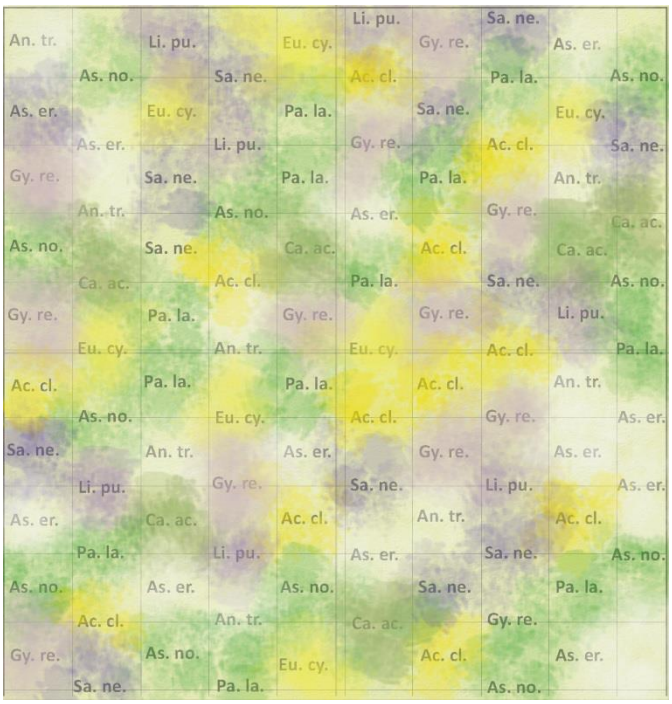


Figure 2.10: Mixture "A" (Flower Haze)

By doing the same way on every mixture we will be able to compare the color combination of each mixture with other mixtures in a certain time.

In this project the created pictures were posted on the internet and people from all over the world have been asked to answer few questions about their feeling toward that pictures, to get a better result, approximately half of the people were told that the images are inspired from plants and other half didn’t have any information about it. In this internet survey 133 Iranian and 51 European participated.

According to this experiment, basis of comparison and questionnaire is the dominant colors of each mixture, how they were spread on the surface and the psychology behind it.

Mixture	Dominant colors in March, April, May, June	Dominant colors in July, August, September, October
A (Flower haze)	Yellow, Green, Silver	Green, Yellow, Silver, Violet, Pink
B (Prairie)	Green, Blue, Brown,	Violet-blue, Pink, White, Green, Yellow, Blue, Red
C (Moist site)	Green,	Green, Pink, Violet

Table 14

According to "BT Journal" each color create special feelings and sensation in human but the regular color psychology does not cover all aspects about colors in nature, for this reason the main focus was on color psychology in "Wildlife research photography" which is the main criterion of those colors in nature (BT Journal).

In following page "Table 15" characteristics and related feeling of colors in planting mixtures in this project is illustrated according to their associative sensations in nature.

Colors in the Mixture	Characteristics and related feelings
Yellow	• Shines with optimism, enlightenment and happiness. • Associated with joy, intellect and energy • The most visible color and is the first color the human eye notices. • Dark yellow in the nature and plantation is a reminder of weeds because most of the noxious weeds bloom in yellow
Green	• The color of peace and ecology • Pervasive color, tranquil and refreshing • It symbolizes growth, harmony, freshness, and fertility. • Natural balance of cool and warm
Silver	• The color of intellect, knowledge, and wisdom, • Color of compromise, perhaps because it sits between the extremes of black and white, • perfect neutral as a background color
White	• projects purity, cleanliness neutrality and safety
Pink	• Youthful, fun, exciting and have the same high energy as red • They are sensual and passionate without being too aggressive. • Toning down the passion of red with the purity of white results in the softer pinks. • Pink is the color of happiness and is sometimes seen as lighthearted.
Violet	• Embodies the balance of red's stimulation and blue's calm • Associated with royalty. It symbolizes power, nobility, luxury, and ambition. • Associated with wisdom, dignity, independence, creativity, mystery, and magic.
Blue	• Blue is seen as trustworthy, dependable, and committed • As the collective color of the spirit, it invokes rest and can cause the body to produce chemicals that are calming • a deeper blue, symbolizes a mystical borderland of wisdom, self-mastery, and spiritual realization • blue is typically the color of communication with others, indigo turns the blue inward to increase personal thought, profound insights, and instant understandings.
Red	• Recognized as a stimulant, red is inherently exciting and the amount of red is directly related to the level of energy perceived. • Red draws attention and a keen use of red as an accent can immediately focus attention on a particular element. • Associated with energy, war, danger, strength, power, determination as well as passion, desire, and love.
Brown	• says stability, reliability, and approachability • It is the color of our earth and is associated with all things natural or organic • It is useful in balancing out stronger colors, and because it is one of the most predominant hues in nature, it gives a sense of familiarity

Table 15: According to "a glimpse into the meaning, symbolism and psychology of color" by Kate Smith

Graphic simulation of mixtures and their color combination in "spring" and "summer":

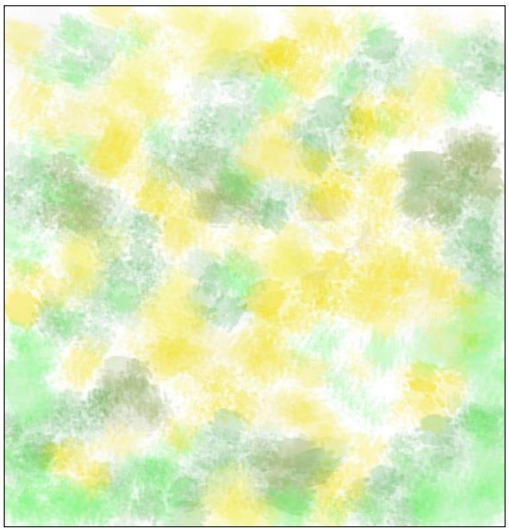


Figure 2.11: Mixture "A" (spring)

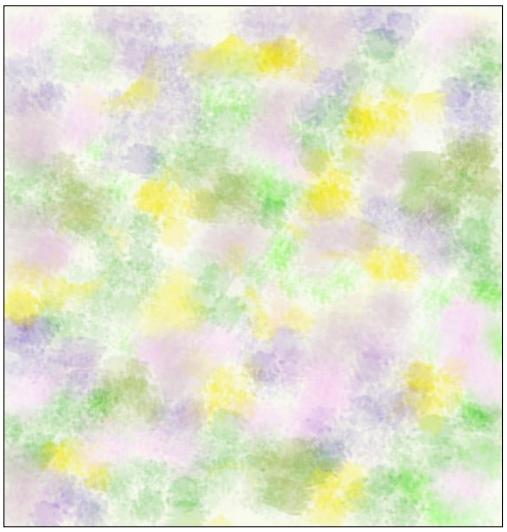


Figure 2.12: Mixture "A" (summer)

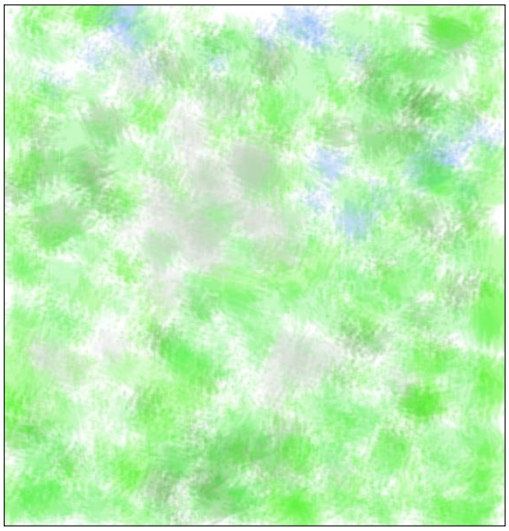


Figure 2.13: Mixture "B" (spring)

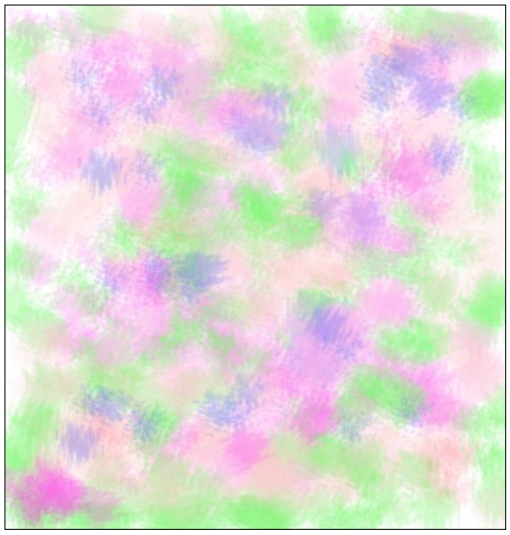


Figure 2.14: Mixture "B" (summer)

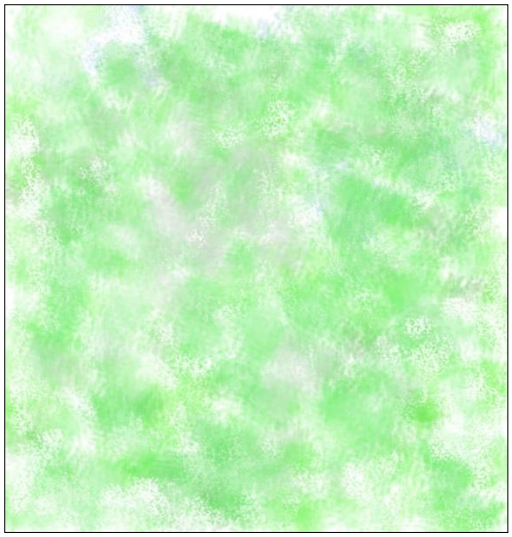


Figure 2.15: Mixture "C" (spring)

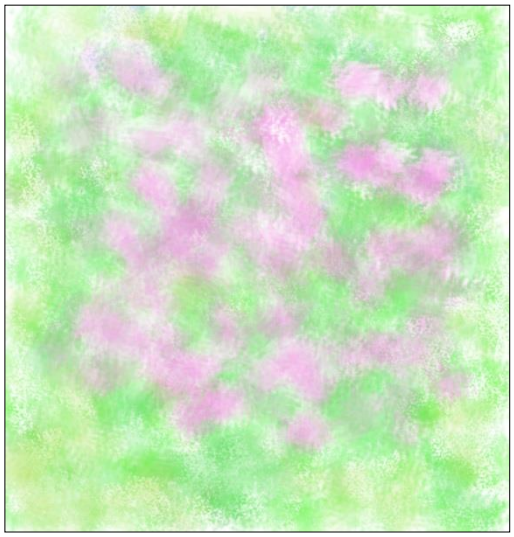
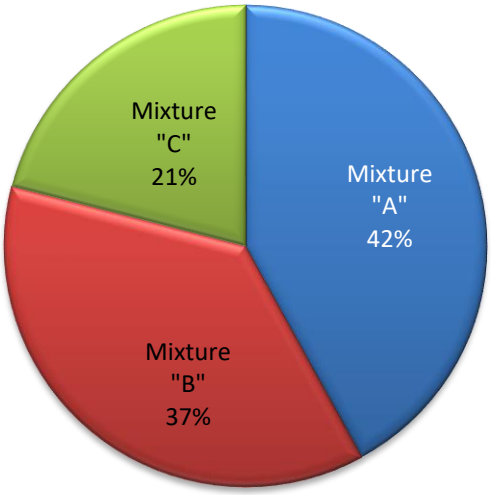


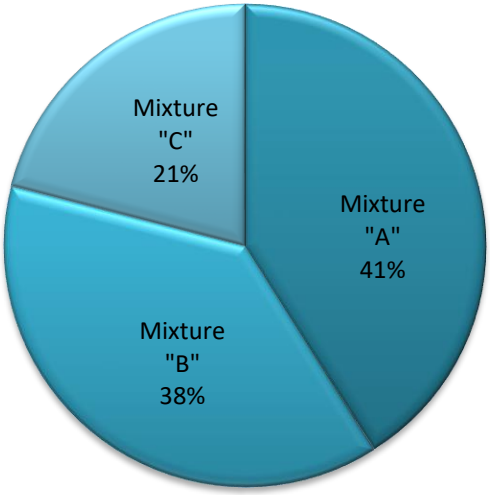
Figure 2.16: Mixture "C" (summer)

Results of internet survey: As it mentioned already, the "graphic simulations" have posted on the internet and 184 people participated on that internet survey. The results are presented as follows according to seasons, nationality and the information given to the people.

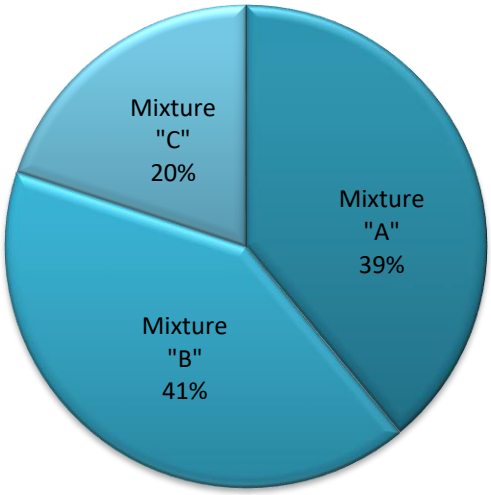
Diagram 9



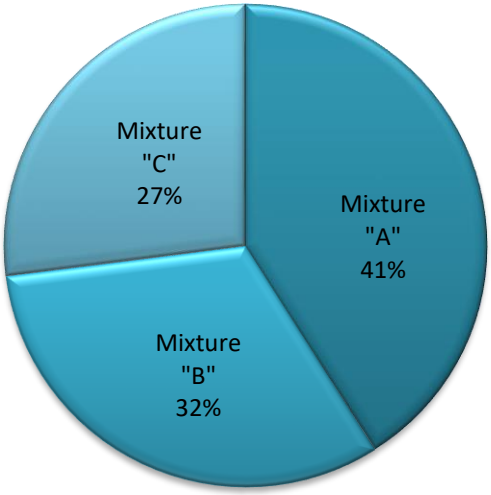
Iranian People



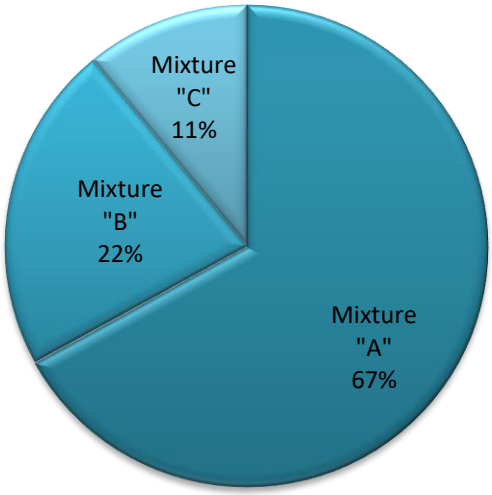
European people



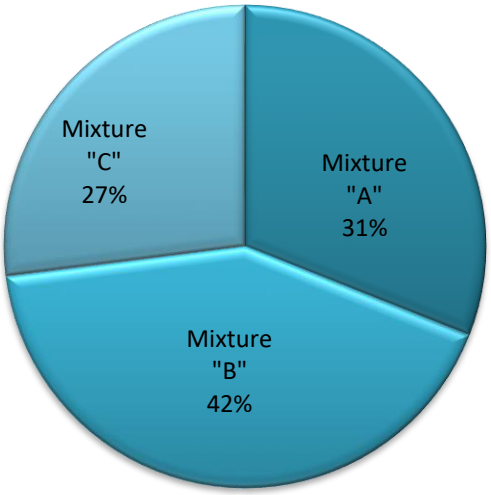
People know about inspiration from nature



People Without information



Spring color combination



Summer color combination

According to general obtained results of internet survey, color combination of mixture "A" (Flower Haze) with a slight difference to mixture "B" (Prairie) was selected by participants as most favorite combination. Among people who were informed about inspiration from nature and planting, mixture "A" was chosen with greater supremacy of other mixtures. Generally, based on statistics, the main competition were between mixture "A" and "B" and it can be possible that the advantage of mixture "A" was making use of more contrast and stronger combination of color "yellow" in spring while mixture "B" in summer has compensated this weakness through creating more variety of colors by adding "violet" and "pink" in the mixture and reach to the equal pleasant level of mixture "A" according to questionnaire.

Figure 2.17: Mixture "A" in spring

Figure 2.18: Mixture "B" in spring

Figure 2.19: Mixture "A" in summer

Figure 2.20: Mixture "B" in summer

Advantages of this visual evaluation method: Making use of the opinions of larger number of people with different cultural background and educational level with different nationalities and take advantage of color psychological methods to analyze the results.

Disadvantages: In this method the only investigated factor is color of perennials and how they were spread on the surface while the texture, structure and height of the plants are not taken into consideration.

2.6.2 Individual monitoring of mixtures

2.6.2.1 Number of each species in the mixtures over the time period

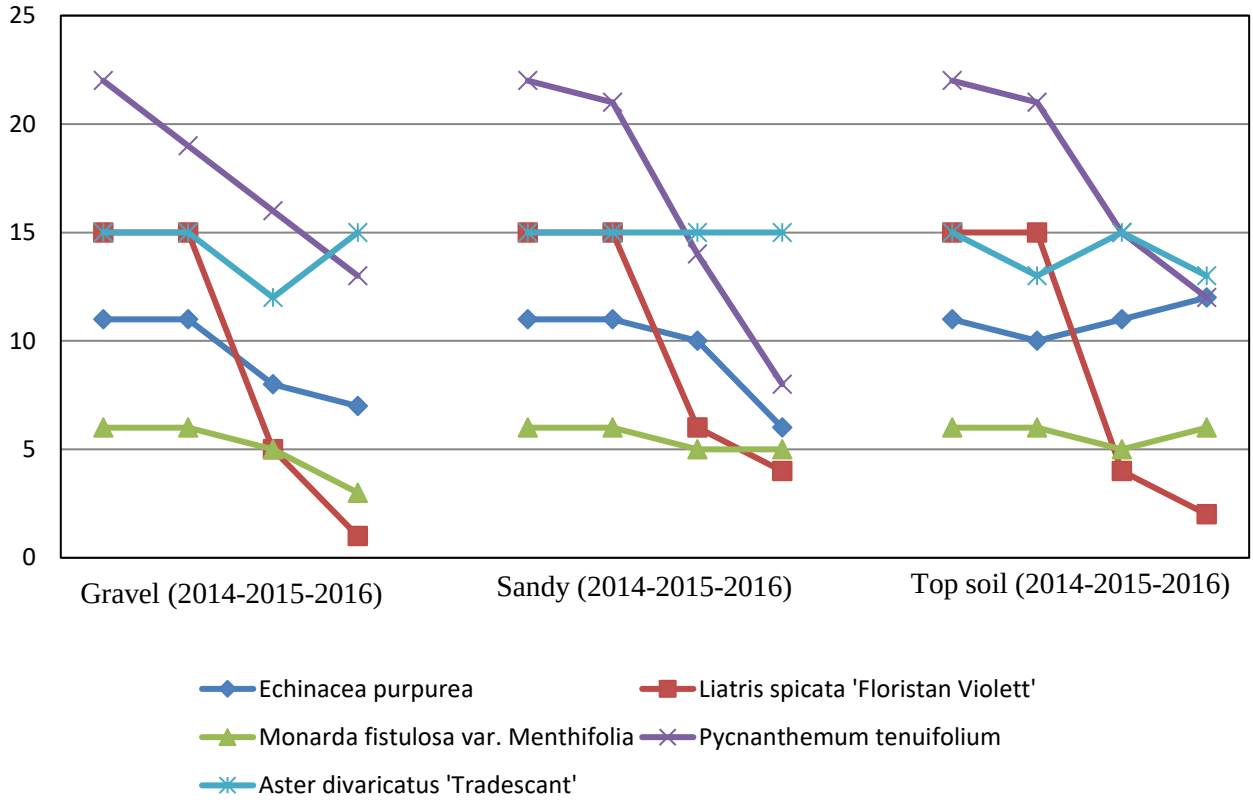
In this part of research the quantity of each species in the mixture over 3 years (2014-2016) will be checked and analyzed. It is shown how the number of some plants didn't change significantly during the time or the number of some of them decreased dramatically or in some species the number remained stable in first 2 years and change started from the 3rd year. As an example following table will show how the numbers of them are recorded for some perennial species in mixture "S2-B-1-x" (prairie in sandy soil) over 3 years from 2014 to 2016.

Time / Species	Quantity in 2014	Quantity in 2015	Quantity in 2016
Echinacea purpurea	11	10	6
Liatris spicata 'Floristan Violett'	15	6	4
Monarda fistulosa var.menthifolia	6	5	5
Pycnanthemum tenuifolium	21	14	8
Aster divaricatus	15	15	15

Table 16

In order to achieve more reliable results, the quantity of each species of perennials over the time period can be compared to other perennials in their own mixture or with exact same perennials with different substrates and all data can be presented on a diagram as following example. For instance the data of those 5 chosen plants in prairie mixture which were shown on upper table has recorded and displayed on following diagram divided according to their substrate to provide a better possibility to analyze the effect of soil on the survival of selected plants.

Diagram 10: Comparison of the quantity in 5 selected perennials of prairie mixture over 3 years from 2014 to 2016 in 3 different substrates (gravel, sandy and top soil).



Conclusion:

Based on obtained results of this method it is possible to figure out which type of soil is more reliable for survival of perennials and also have a better understanding of survival power of each perennial in a period of time. According to different behavior of plant types in a mixture they can be categorized into "Long-live" and "Short-live" perennials so with the correct use of them it is more possible to have remarkable results (aesthetically and biologically) in short term and long term periods.

2.6.2.2 Vitality of perennials

Generally vitality in a plant refers to the capacities to live, grow or develop as well as to resist stress (Dobbertin 2005). Therefore understanding plant vitality is essential to the maintenance of healthy perennials. Plants vitality is usually assessed by their growth and/or their physiological measurements. In this research vitality of perennials is evaluated by grading system so that the health status of each perennial was graded from "1 to 9" based on the following categories:

1- Very low (nurture growth)
3- Low
5- Middle
7- Strong
9- Very strong (optimal growth)

As an example, part of this assessment is illustrated in 2 following tables; "Table 17" shows vitality in one single perennial type (e.g. Agastache foeniculum) in 3 different substrates and "Table 18" shows the comparison between vitality degrees of plants in mixture "A" (Flower Haze) with sandy substrate in 4 different irrigation patterns. (Complete results in Appendix 5)

Average vitality degree of "Agastache foeniculum-Blue Fortune" in 3 different substrates in 2015 and 2016 (Mixture prairie)								
Plots / Substarte	S(1,2,3)-B-1-x		S(1,2,3)-B-2-a		S(1,2,3)-B-2-b		S(1,2,3)-B-2-c	
	2015	2016	2015	2016	2015	2016	2015	2016
Gravel	3	1	2	0	3	0	3	5
Sandy (Perennial substrate)	8	5	9	4	7	4	6	7
Topsoil	7	7	0	0	2	0	1	0

Table 17

Average vitality level of perennials in mixture "A" –Flower haze with sandy substrate in 4 different irrigation patterns in 2015 and 2016								
Plots / Plants	S2-B-1-x		S2-B-2-a		S2-B-2-b		S2-B-2-c	
	2015	2016	2015	2016	2015	2016	2015	2016
Achillea clypeolata	3	5	5	4	5	0	7	4
Aster novae-angliae	6	8	7	9	5	5	9	6
Aster ericoides	8	5	7	7	8	5	8	5
Calamagrostis x acutiflora	9	7	7	7	9	6	6	6
Euphorbia cyparissias	8	7	7	8	9	7	6	7
Anaphalis triplinervis	8	6	7	6	9	7	7	5
Gypsophilia'pink star'	8	8	9	7	9	9	9	9
Linaria purpurea	6	5	9	5	9	7	5	7
Salvia nemorosa	9	8	5	5	5	5	6	7
Papaver atlanticum	7	6	7	3	5	7	7	7

Table 18

Conclusion:

Inference from "Table 17", it is possible to recognize which substrate is the most acceptable option in order to achieve highest grade of vitality and optimal growth in perennials and "Table 18" provides an opportunity to compare healthiness level of all perennials in a mixture in the last 2 consecutive years. It is also can be observed how different amount of irrigation can effect on their vitality level.

According to the average result of this experiment in "Appendix 5", sandy soil (perennial substrate) is diagnosed as the most desirable substrate and mixture "A" (flower haze) gained highest average rate of vitality with slight advantage to mixture "B"-prairie. (In this experiment, the amount of irrigation has been made no significant change in general results)

2.6.2.3 Coexistence

According to "Cambridge Dictionary" literal meaning of the word "Coexistence" is "To live or exist together at the same time or in the same place despite differences" and this word can be applicable in the botanical world so that nowadays understanding the mechanisms of species coexistence is a key task for ecology and achieves cost effective and higher quality landscaping. Coexistence theory in plantation explains how competitor features can maintain species diversity and obviate competitive exclusion among similar species living in ecologically similar environments.

In this project based on the observation during the experimental period (years 2015 and 2016) each plant got an average rate of coexistence in the mixture which is categorized according to the following division:

7 = Repress others strongly	-7 = Very strongly suppressed
5 = Repress other species	-5 = strongly suppressed
3 = Medium Repression of others	-3 = Medium suppressed by others
1 = Repress others barely	-1 = A little suppressed
0 = Do not disturb the balance	

In this part, 3 perennials (one dominant, one companion and one ground cover) of mixture "A-flower haze" in sandy soil (perennial substrate) are chosen to be presented as an example of wide range of coexistence in a mixture. (Complete results in Appendix 6)

Coexistence rate of 3 selected perennials in Mixture "A" of "sandy soil" in 2015				
	S2-A-1-x	S2-A-2-a	S2-A-2-b	S2-A-2-c
Calamagrostis x acutiflora (Dominant)	-1	-1	-1	0
Gypsophila'Pink Star' (Ground cover)	3	5	7	2
Linaria purpurea (Filler)	-3	0	-2	-3

Table 19

All recorded information about coexistence of Bernburg perennial mixture project in 2015 and 2016 can be found in "Appendix 6".

Conclusion:

By making use of these data, it can be seen that the dominant perennials in the mixture have the average grade close to the "0" which means they are not tended to change their position in the mixture, they do not compete out others and will not be competed out by others while ground covers have the average coexistence rate around "3" or higher which shows they will move through the mixture strongly but they will fill the lower spaces, companion perennials show similar characteristics with dominants (stay stable) while fillers mostly have the minus average grade which means they will be suppressed by other species by the time. So the result will allows understanding which plant will fulfill the function and the purpose of the project and which perennial need to be replaced with other alternatives to achieve the expected results.

2.6.2.4 Height

Record plant heights in different time periods is necessary to understand under what conditions (substrate, irrigation,…) plants are in their optimal state or whether they reached to the optimum plant height or not. On the other hand one of the main criteria in classification of perennials in dominant, companion and ground cover is the structure and height of them compare to other plants in their mixture.

In following table as an example "Calamagrostis x acutiflora" is chosen from mixture "A" to show its height in different substrate and irrigation amount in 2016. (Complete result in Appendix 7)

Measured height in 2016 (Centimeter)												
Substrate	Gravel				Sandy				Topsoil			
Row / Species	a	b	c	x	a	b	c	x	a	b	c	x
Calamagrostis x acutiflora 'Overdam'	70	60	-	60	140	140	120	130	140	130	110	120

Table 20

In the following table 2 dominant, 2 companion and 2 ground cover perennials in mixture S2-B-2-a (prairie in sandy substrate) is presented as an example of classification in the mixtures according to their height. (Complete result in Appendix 7)

Mixture "S2-B-2-a" in 2016	
Species	Height
Dominant	
Aster ericoides 'Pink Star'	130 cm
Solidago caesia	120 cm
Companion	
Echinacea pallida	100 cm
Penstemon digitalis 'Huskers Red'	80 cm
Ground cover	
Artemisia ludoviciana 'Silver Queen'	40 cm
Oenothera pilosella	25 cm

Table 21

Based on the obtained results from Appendix 7, sand soil (perennial substrate) provided proper condition for the perennials to reach to their optimal heights and fulfill their function in their mixture as dominant, companion or ground cover elements.

2.6.3 Weeds

Weeds are one of the main challenges for plantation in public spaces so that the excessive weeds can increase maintenance costs and reduce efficiency of the project, therefore in order to create a cost effective program, conditions should be managed in a way to minimize the amount of weed as much as possible, for that reason in Bernburg perennial mixture project in 2016 the amount of weeds were recorded for each plot in different soil types (substrates), mixtures and irrigation pattern. Part of these recorded data as an example is presented in following table and diagram. (Complete data can be found in Appendix 8)

Because Wetland mixture (C) is not site-conform and it needs special interpretation, it is not included in this table. (Since Mixture "C" belongs to the moist sites, the high amount of weed is expected and it is predictable).

	Total time of collecting weeds per "square meter" in "minutes" in 2016									
Row / Substrate	Mixture "A"-Flower haze					Mixture "B"-Prairie				
	a	b	c	x	Ave	a	b	c	x	Ave
Gravel	0.25	0.13	0.13	0.27	0.20	0.13	0.17	0.21	0.17	0.17
Sandy	0.21	0.13	0.21	0.07	0.16	0.33	0.29	1.08	0.53	0.56
Top soil	0.46	0.58	0.58	0.67	0.57	0.50	0.67	0.50	0.67	0.59

Table 22

Two main applicable methods to measure the amount of weeds in a plantation plot is the average time of collecting them and weed's total weight measurement. In the table above the time which is needed to take the weeds out is chosen as assessment criteria because in some cases the soil is so rich with lots of nutrients so that weeds can reach to a bigger size and their weight increase while it doesn't mean that the amount of weeds increased in that certain plot (not many but heavy weeds) so in this case the time which is required to collect the weeds can lead us to more reliable results in weeds assessments.

Conclusion:

Based on the Table 22 and appendix 8, it is observable that, on average, the amount of weeds in "Topsoil" is significantly higher than other substrates that lead to an increase in time and costs of maintenance while using artificial substrates (Sandy) can be a better option to achieve optimal result.

* According to Table 22, mixture B-Prairie in row "C" experienced unusually high amount of weed that one of the possible interpretations is since row "c" had less irrigation, it was too dry for prairie mixture to make such good covering in their plot and didn't grow dense enough to compete against weeds (they don't have competition power) so for that reason weeds had enough space (gaps) to spread through the plot.

2.7 Chapter conclusion

In this chapter according to methods, data analysis and obtained results from Bernburg perennial mixture project, in order to achieve maximum efficiency, following results can be applicable:

- In total, sandy soil (perennial substrate) by creating an efficient drainage system is the most reliable substrate compare to other experimented cases. It has good structure for keeping moisture and providing enough air and space so that even with less irrigation it is possible to have acceptable results visually and biologically. Although providing artificial soil, free from weeds, can be costly at the start of project but in a long term it will be an economical and productive decision.

- Although in many case of analysis, the amount of irrigation didn't make any significant change on the results but it is also observable that by choosing the proper substrate it can be possible to limit the irrigation to 1 time per 4 weeks and still achieve acceptable results, while this information can be promising and useful for the next chapter introducing proposal trial from Iran which is located in a dry climatic zone.

- Based on the output of this chapter, among 3 tested mixtures, "A-Flower haze" and "B- Prairie" were selected respectively with little difference as superior mixture in terms of visual and biological features which the reasons are described in assessment methods.
- In order to prove that "making use of artificial soil, free from weeds is more economical decision in a long term compare to the cost of maintenance" a cost calculation has been applied according to cost database of a landscape company and an interview with a construction project manager.

1- Cost of creating $1m^3$ with artificial soil (Substrate): (40 cm depth)

A- Averagely a worker needs 70 minutes to dig $1m^3$ and fill it with light substrate

One hour work (regular worker) = 12.09 € ⟶ 70 minutes work = 14.11 €

B- Price of substrate (according to the price of "Hygromix" and "Gelsenrot" Co.)

$1m^3$ = 25,5 € + Delivery costs

Total cost for $1m^3$ with artificial substrate = A+B = <u>39.61 €</u>

2- Cost of maintenance of $1m^2$ in topsoil:

According to cost database for maintenance of $1m^2$, a worker needs 13.23 minutes including irrigation, remove weeds, plant care or fertilizing while only 2.5 minutes considered for removing weeds.

One hour work (gardener) = 15.09 € ⟶ 2.5 minutes work = 0.88 €

Averagely we need 10 times per year for maintenance so:

10 x 0.88 € = 8.80 € cost of maintenance

* So according to the calculation we need approximately 4-5 years to pay-off the cost of buy and apply of artificial substrate in a project.

** The above calculations are approximate and by taking into account the existing soil type, the cost of delivery (transportation) and gravel coverage of surface, the results would be different.

- As a result, in order to achieve an acceptable result (aesthetically) a certain cost is required.

3.1 Geographical features of Iran

Location:

Iran is located in south-west of Asia and borders Armenia, Azerbaijan and Turkmenistan, as well as the Caspian Sea to the north, Turkey and Iraq to the west, the Persian Gulf and the Gulf of Oman to the south and Pakistan and Afghanistan to the east.[1]

Climate:

Iran has a variable climate. In the north-west, winters are cold with heavy snowfall and subfreezing temperatures during December and January. Spring and autumn are relatively mild, while summers are dry and hot. In the south, winters are mild and the summers are very hot, having average daily temperatures in July above 38 ° C. On the coastline of Caspian Sea and Khuzestan Plain, summer heat is accompanied by high humidity. Generally, Iran has an arid climate in which most of the relatively little annual precipitation falls from October through April. In most of the country, yearly precipitation averages 250 millimeters or less. The major exceptions are the higher mountain valleys of the Zagros and the Caspian coastal plain, where precipitation averages at least 500 millimeters annually. In the western part of the Caspian, rainfall exceeds 1000 millimeters annually [Germany average rainfall is around 700 millimeters annually] and is distributed relatively evenly throughout the year. This contrasts with some basins of the Central Plateau that receive 100 millimeters or less of precipitation. [2]

Figure 3.1

1 http://www.aitotours.com/aboutiran/3/geography/default.aspx
2 http://www.iranicaonline.org/articles/flora-ii-in-persia

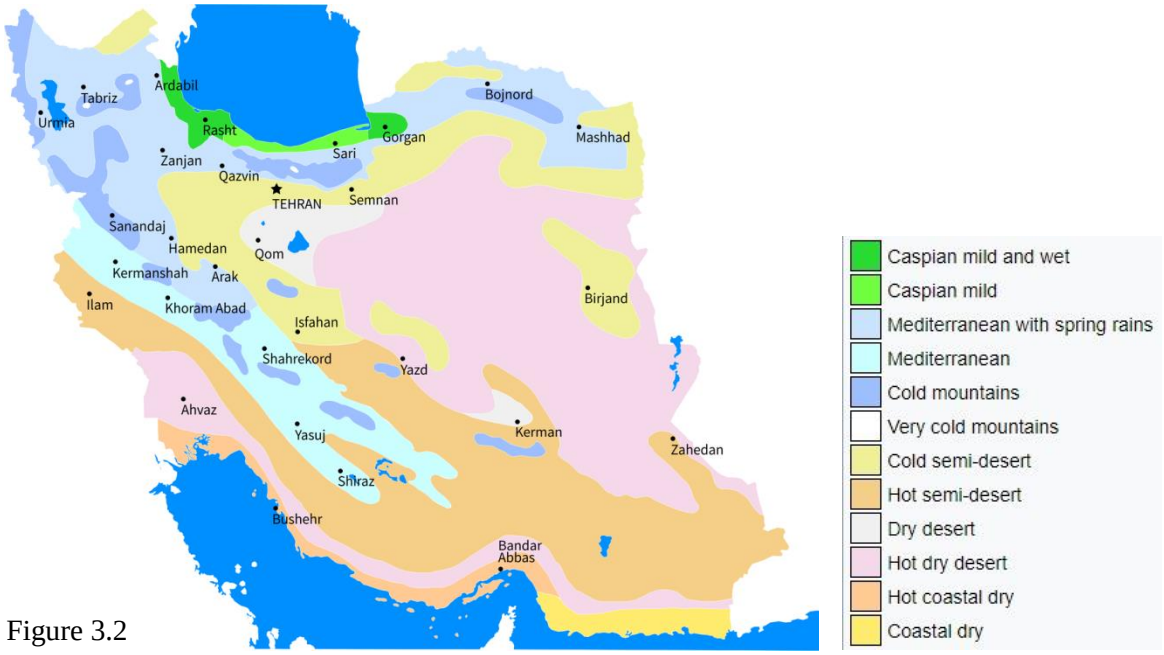


Figure 3.2

Topography:

The topography of Iran consists of rugged, mountainous borders surrounding Central plateau of Iran. The main mountain chain is the Zagros Mountains, a series of parallel ridges spread with plains that divide the country from north-west to south-east. Many peaks in the Zagros exceed 3000 metres above sea level, and in the south-central region of the country there are at least five peaks that are over 4000 metres. As the Zagros continue into southeastern Iran, the average elevation of the peaks declines dramatically to under 1500 meters. On the south part of Caspian Sea there is another chain of mountains, narrow but high Alborz Mountain. Volcanic Mount Damavand, 5610 metres, located in the center of the Alborz, is not only the country's highest peak but also the highest mountain on the Eurasian landmass west of the Hindu Kush. [3]

The central part of Iran is referred as Central Plateau. The eastern part of the plateau is covered by 2 salt deserts, Dasht-e Kavir (in the heat of summer is one of the hottest places on the planet) and Dasht-e Lut [total area of both 129400 km^2, nearly 0.40 size of Germany], except some oases these deserts are uninhabited. Iran has only 2 expanses of lowlands, the Khuzestan Plain in the south-west and the coast line of Caspian Sea in the north.[3]

3 http://nationalgeographic.com/explore/countries/iran
http://www.iranicaonline.org/articles/flora-ii-in-persia

Figure 3.3

Ecosystem, Flora and biosphere:

Iran has its specific combination of different elements of life and a special ecosystem and biodiversity due to various factors including different climatic zones, high mountains all around the country and a large desert in center. Different phytogeography regions in Iran's plateau cause massive genetic flow in this area which result in a variety of plant species. Some plant species have been walled inside the natural fences (as native), and some are scattered in other lands. Most part of Iran is occupied by Deserts and semi-deserts. Due to the diversity of climate, topography and edaphic (specific soil type) conditions, limited areas of vegetation in Iran, are very different and diverse. Vegetation in Iran, in particular, consists of separated and limited areas. Its coverage in the northern, western and northwestern areas and humid regions is very high, but in arid areas with low precipitation and high evaporation is very low. (Ghahreman & Attar, 2000)

However, there is very high plant diversity in Iran which is remarkable and comparable with other countries. Iran consists of 167 families of vascular plants, 1215 genera, some of them only by one species and some of them by about 800 species (Astragalus). Total Taxa in Iran are about 8,000 which include about 6417 species, 611

subspecies, 465 varieties, and 83 hybrids. Of these, about 1,810 are native to Iran. [4] (Ghahreman, A. & Attar, F. (2000): Biodiversity of plant species in Iran, vol. 1. Tehran University publications)

According to the classification of Armen L. Takhtajan (1986) for the plants geography there are 6 phytogeographical regions (flora kingdoms) which the greater part of Iran is included in the *Holarctic* kingdom. Holarctic kingdom mainly consist 4 *floral regions* while the main concentration of this study is on the *Irano-Turanian floral region* which extends from Central Asia to the North Africa (Zohary, 1973).

Since 16th century many researchers have collected and described plants from Iran, main pioneers among them were Samuel Gottlieb Gmelin and Peter Simon Pallas (1770-72), André Michaux (1782), Theodor Kotschy (1841-42), Engelbert Kaempfer (1864-68) and Edmond Boissier, in his *Flora Orientalis* (1867-88). The reports of Joseph Friedrich and Nicolaus Bornmüller, who traveled widely and published their experiences, increased significantly knowledge of the flora of the Middle East. In the years 1943-60 the Iranian botanist Ahmad Parsa published an eight-volume flora of Persia. Aside from expanding botanical knowledge, his great contribution was the translation of Boissier's Latin identifications into French. The collections made by Paul Allen, Mogens Køie, Ian Charleson Hedge, and Per Wendelbo have contributed expressively to knowledge of Persian flora. Their works have provided a valuable basis for *Flora Iranica* (q.v.) of Karl Heinz Rechinger, the leading expert on the flora of Persia. Rechinger, who carried out a number of field studies, published the first comprehensive flora of the Iran's highlands, fulfilling an important prerequisite for geobotanical research in Iran. More recently, Jean Joseph Léonard (1981-92) published a flora of the central desert region.[5]

Although the flora of Iran is fairly well known, there are still very few works on the general vegetation. Alexander Gilli pioneered research on plant communities in the Alborz range (1939). Harry Bobek pursued diverse geographical studies in Iran, including fundamental work on plant geography. Most notable is his work on natural woodlands (Bobek, 1951). Michael Zohary (1963), and Sadegh Mobayen and Viktor Tregubov (1970) were the first to undertake complete descriptions; Zohary dealt in detail with the

4 Present statistics are adopted from the surveys conducted in 2000 in Central Herbarium of University of Tehran.

5 http://www.iranicaonline.org/articles/flora-ii-in-persia

vegetation of Iran in *Geobotanical Foundations of the Middle East* (1973), which provides an excellent general survey and a number of detailed studies. From 1972 to 1985 the vegetation of Iran has been studied within the structure of Special Research TAVO (Wolfgang Frey, Wolfgang Kramer, Harald Kürschner, Wilfried Probst). Recently, Jean Claude Klein (1982-94) published studies on the high mountain vegetation of the Alborz.

Soil pattern:

The abundant subtropical vegetation of the Caspian's coastal region is supported by rich brown forest soils. Mountain soils are shallow layers over bedrock, with a high proportion of fragments [partially rich soil can be found in mountain ranges]. Natural erosion moves the finer textured soils into the valleys, these muddy deposits are mostly chalky. The semi-aired plateaus are covered by brown or chestnut-colored soil that supports grassy vegetation. The soil is slightly alkaline and contains 3 or 4 percent of organic material. The saline and alkaline soils in the arid regions are light colored and infertile. The sand dunes are composed of loose quartz and fragments of other minerals. Except where protect by vegetation, they are in almost constant motion, driven by high winds.[6]

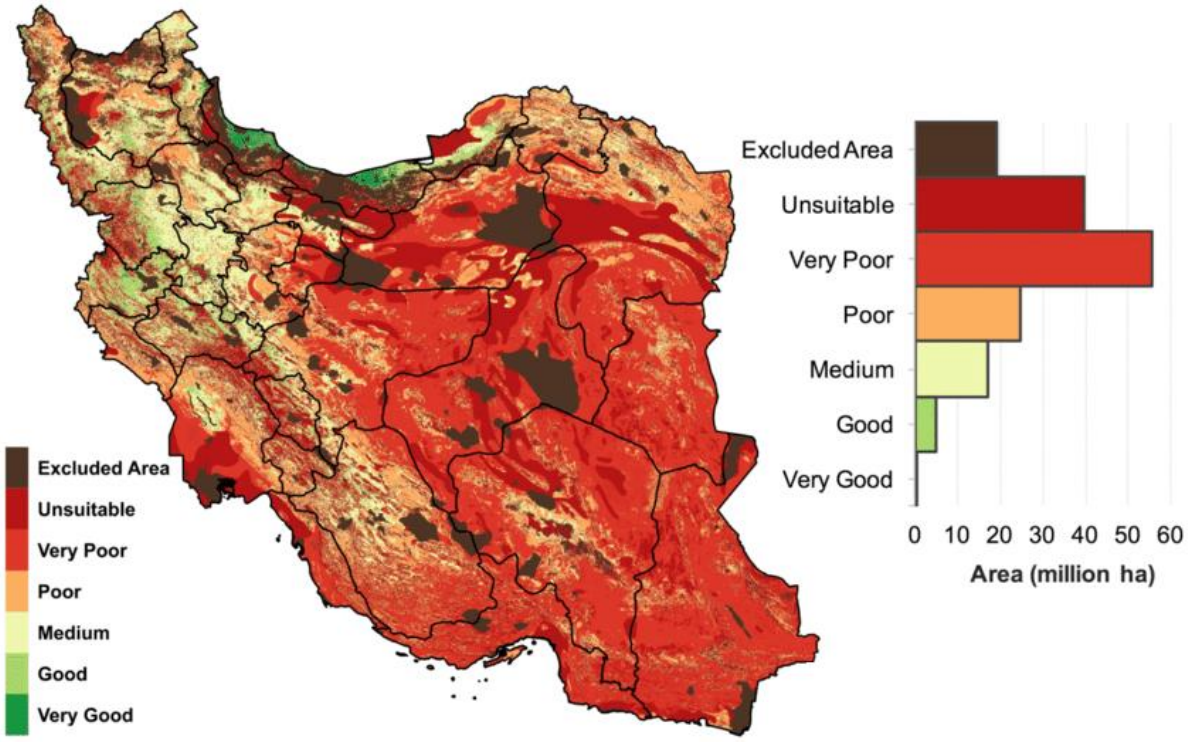


Figure 3.4: Soil quality- Stanford Iran 2040 project

6 http://nationalgeographic.com/explore/countries/iran

Water Sources and Precipitation:

There are several large rivers in Iran, but the only navigable one is Karun (890 km). The largest rivers are: Karun (890 km), Sefidrood (765 km), Karkheh (755 km), Mand (685 km),… . Most streams are seasonal and variable, sometimes spring floods do enormous damage, and there is little water flow in summer when many streams disappear. Water is however stored naturally underground, finding its place in subterranean water canals (Qanat) and be trapped by well.

Lake Urmia (north-west of Iran) is Iran's largest body of water which is a permanent salt lake and the content of salt is too high to support fish or other forms of aquatic life. Real fresh water lakes are pretty rare in Iran, not more than 10 lakes in the whole country.

Caspian Sea, which is the largest land-locked body of water in the world (424,240km^2) provide moisture and fertility for the north part of Alborz Mountains. [7]

Most of the fertile areas in Iran are due to moisture of Caspian Sea trapped by Alborz Mountains which appears as rainfall in the north part of Iran and the relative moisture of western part of Iran came from Mediterranean Sea and Black Sea kept by Zagros Mountains and also appears as rainfall in west and north-west of Iran.[8]

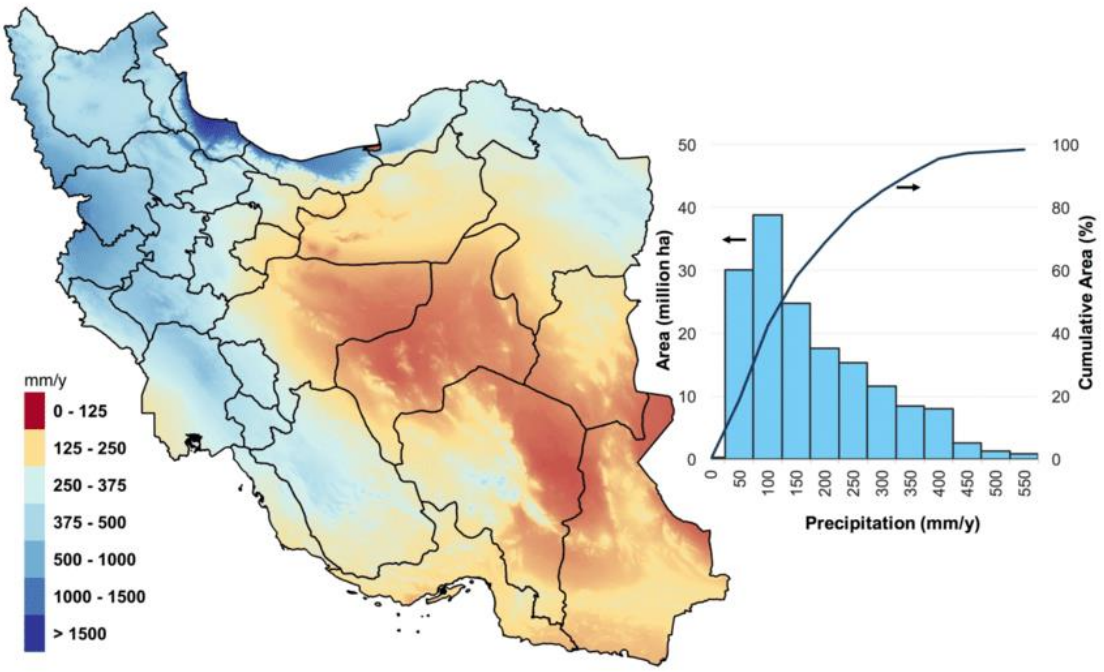


Figure 3.5: Average annual Precipitation- Stanford Iran 2040 project

7 http://nationalgeographic.com/explore/countries/iran
8 Geographic database of Islamic Republic of Iran published by University of Tehran

3.2 City landscape in Iran

Due to inadequate research in the field of 'City Landscape', absence of guide sources and lack of sufficient knowledge in responsible authorities of Iran about perennials and application of Iran's indigenous and native ornamental plants in beautification of urban areas, obtained results in cities of Iran are disappointing and inefficient.

In Iran's city landscaping, non-native, annual and bulbous plants are mainly used for a short term in a year to prepare the appearance of the city for a special occasion or ceremony and in the rest of the year image of the city will only be covered by excessive and monotonous use of one species of trees which are repetitively cut due to lack of proper city management, change the usage of urban spaces or changing traffic plans while replacing them will require time and significant financial resources.

Figure 3.6: Non-native trees in north of Iran

Figure 3.9: Lack of maintenance

Figure 3.7: Undesirable design of annuals in Tehran

Figure 3.10: monotonous use of one species tree (conifers in Qazvin)

Figure 3.8: Replacement of old trees with non-native plants

3.3 Proposal

By inspiring from Bernburg perennial mixture project and making use of all information and extracted results, in this part of research based on background and personal experience of author and extreme needs for the area, the country of Iran has been chosen for introduction of perennial mixture trials by taking advantage of indigenous perennials of Iran. According to all explained reasons in order to increase the efficiency and chance of success, all obtained results from Bernburg perennial mixture project and experimented methods need to be generalized on Iran's perennial mixture trials.

Based on preliminary analysis of Iran's geographical features and duo to more suitable environmental conditions such as climate, precipitation, soil pattern, ecosystem and variety of indigenous plants, recorded database of flora and having access to more reliable information, 4 western provinces of Iran (mainly province of 'Ilam' and 3 others are control sites) are selected as experimental environment. The characteristics of selected area make it possible to generalize the results to other similar area in Iran or even other countries such as Turkey, Iraq, Syria, Afghanistan, Israel and Lebanon.

This part of research means to introduce some possible examples of native perennial mixtures in Iran to take the first step of this process but in order to achieve real result of this experiment, introduced mixtures need to be tested according to explained methods in chapter 2 on a real site in the future.

3.4 Characteristics of selected area

As it was mentioned already the selected area includes 4 provinces (mainly province of 'Ilam' and 3 others are control sites) in west of Iran which are recognized as proper experimental site for this research. This region has a climate close to the Mediterranean that is accompanied with spring rains and located on the range of Zagros highlands in an area with scattered forests and that's the reason why this region in some parts is taking advantage of fertile rich brown forest soil. In comparison with other parts of Iran this area has higher average of precipitation (except coastline of Caspian Sea) which is recorded from 500 to 1500 millimetre per year. All these factors have caused varied biodiversity in the region and turn it to a favorite area for botanists and environmental researchers. Ilam province as main experimental site in this research with the total area of 20,150 km^2 also called as "Bride of Zagros" includes many different climatic zones; the southern and western parts are covered by plains, hilly areas and even deserts while the eastern and northern parts are covered by mountainous area and 500,000 hectares forests with wider variety of biological species.[9]

Since 2001 many botanists in Iran concentrated on this zone and their findings were more than 1,000 species which most of them are recorded in books 'Flora of Ilam' (V.Mozafarian 2013), 'Recognition of Ilam's Medicinal plants' (V.Mozafarian, A.Piri 2015), 'Plant types in Ilam province' (M.Jafari, J.Hoseinzadeh, M.Mohammadpour, A.Azami, A.Najafifar, M.Fayyaz, 2015), 'Medicinal plants of Ilam province' (H.Ahmadi, K. Chamangol 2012) and 'Introduction of Ilam's medicinal plants' (A.Mezbani, R.Ahmadi 2014) and all these sources create a reliable datacenter for all type of specific studies in this certain region.

Figure 3.11: Province of Ilam

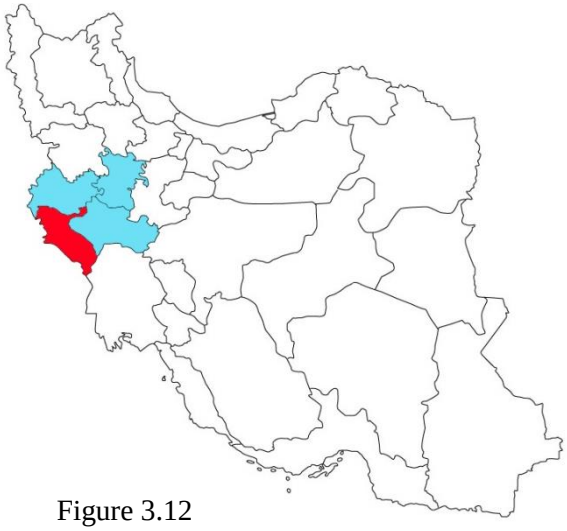


Figure 3.12

9 Cognitive plan for ecologic zones of Iran (M.Jafari, J.Hoseinzadeh, 2010)

3.5 Performance method of collecting plant species [10]

In this research in order to collect suitable perennials the following steps have been taken:

Step 1: Considering all recorded flora of Ilam according to the resources.

Step 2: The annual plants which are tended to be weedy are excluded from the list.

Step 3: Plant species belong to wetland or desert area are excluded from the list.

Step 4: Plants which are not delicate, too big or small, without aesthetic value or even not compatible with the research criteria have been taken out.

Step 5: Plants with weedy or invasive characteristics are excluded.

Step 6: Plants which are hard to cultivate are removed from the list.

Step 7: Most delicate perennials which are matched with strategy, theme, texture and category of perennial mixtures (dominant, companion …) are selected as final list of perennials.

Figure 3.13: Nature of Ilam, photo: Naser Golnazari

Figure 3.14: Nature of Ilam,

Figure 3.15: Nature of Ilam,

Figure 3.16: Nature of Ilam, www.ilamtoday.com photo: Gheysar Keshavarz

10 By help and consultant of Dr.Solmaz Tavakoli, Lecturer in Payame Noor University of Ahwaz, Iran

3.6 Themes

In this project, 2 main themes are considered to create perennial mixtures. First theme is making use of 'Random perennial mixture' strategy by dividing the perennials into 5 categories of dominants, companions, fillers, groundcovers and bulbous perennials and the main target is making a combination with acceptable, neat and tidy looks and natural appearance over a complete year (in this theme the methods of Bernburg project can be applied).

Second theme is making use of "Cushion form" perennials and their combination with "narrow vertical growing" perennials. 5 main general criteria for "Cushion theme" need to be considered to achieve expected results.

1- Do not using loose growing perennials in the mixture.
2- Combine cushion form perennials with tall and vertical growing one as dominants
3- Making use of slim growth perennials to scatter between cushions
4- Do not create shade over cushions
5- Use hazy growth perennials as companion

Figure 3.17: Visualization of "Cushion theme", drawn by author

3.7 Introduction of selected perennials

By passing through mentioned process considering chapter 3.5, performance method of collecting plant species, 54 perennials are selected for inclusion in the main mixtures. Perennials are divided in 6 different groups; Dominants, companions, fillers, groundcovers, bulbous and cushion form perennials and each group will be explained separately. Main parameters of each perennial's introduction are their family, blooming color, blooming time, height, their origin (native of which country) and finding location of them in Iran and other details such as their Iranian name and … will be mentioned beside main factors. Due to the large number of selected perennials, in this part 11 perennials are chosen for introduction. For more information and images about all other species following resources are available:

- Book "Flora of Silk Road" (Christopher Gardner, Bashak Gardner) - in English
- Book "Flora of Ilam" (V.Mozafarian 2013) - in Persian
- Website "www.photos.v-d-brink.eu/Flora-and-Fauna/Asia/Iran-Zagros mountain/" (Marjin van den Brink)- in English
- Book "Recognition of Ilam's Medicinal plants" (V.Mozafarian, A.Piri 2015) in Persian
- Book "Plant types in Ilam province' (M.Jafari, J.Hoseinzadeh, M.Mohammadpour, A.Azami, A.Najafifar, M.Fayyaz, 2015) - in Persian
- Book "Medicinal plants of Ilam province" (H.Ahmadi, K. Chamangol 2012) in Persian
- Book "Introduction of Ilam's plants" (A.Mezbani, R.Ahmadi 2014) - in Persian

Perennials	Family	Persian name	Height (cm)	Blooming color	Origin
Alcea kurdica	Malvaceae	Khatmi	140	Lemon yellow	Iran, Iraq
Asphodeline lutea *	Asphodelaceae	Meele Yaghoub	110	Yellow	Turkey
Calamagrostis x acutiflora **	Poaceae	Alaf Ney, Siyah Sonbol	140	Brown-Green	Hybrid
Campanula bononiensis	Campanulaceae	Gol Estekani	90	Light Violet	Iran, central Europe, central Asia
Crambe orientalis	Brassicaceae	Sepideh	110	White	Iran, west Asia
Delphinium cyphoplectrum	Ranunculaceae	Gol-e-Sheveedi	110	Blue-Violet	Iran, Armenia, Turkey, Iraq
Eremurus spectabilis	Asphodelaceae	Serish	90	White	Iran, Turkey, Iraq, Syria, Afghanistan
Eremurus persicus	Asphodelaceae	Serish-e-Irani	80	White	Iran, Afghanistan, Pakitan
Eremostachys laciniata	Lamiaceae	……..	80	White-Cream	Iran, Turkey, Syria
Phlomis bruguieri ***	Lamiaceae	Fetileyi, Goosh Bare	140	Bright yellow	Iran, Turkey, Syria

Table 23: Selected dominant perennials

* According to author's findings, *Asphodeline lutea* is not native of Iran but it can be found commonly in the area of study.

** *Calamagrostis x acutiflora* is a dry resistant hybrid which is compatible with characteristics of the location of study.

***Another native alternative for *Phlomis bruguieri* is *Phlomis persica*.

3.7.1.1 Eremurus persicus

Family: Asphodelaceae

Distribution: Iran, Afghanistan, Pakistan

Height: 70-90 cm

Flowering period: April-June

Blooming color: Snow white

Flower shape and texture:

Fine texture grape-like flowers

Leaves shape and texture:
Grow in tufts of thin, strap-like strips, tufted together on the plant base.

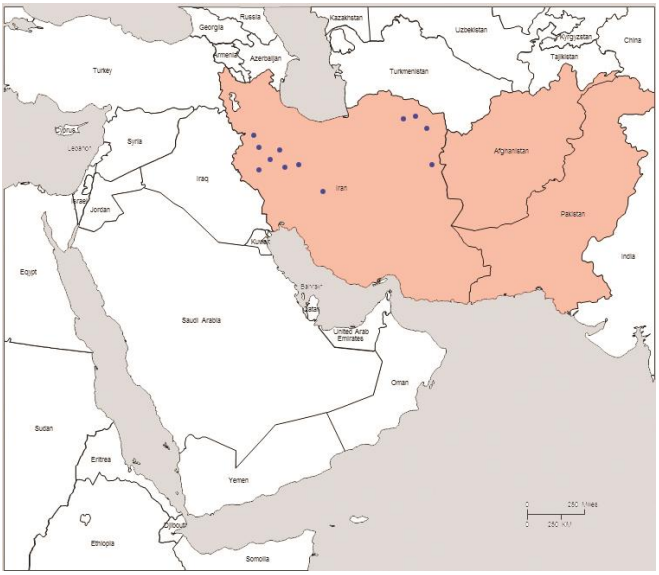


Figure 3.18: Distribution of *Eremurus persicus*

Form of growing: Tall and narrow growing with leave-less inflorescences.

The genus *Eremurus* comprising nearly 50 species is mainly restricted to central and western Asia (Chong et al, 2000) and 6 species are known to exist in Iran. *Eremurus persicus* locally called "Serishe-e-Irani" is widely distributed in east and west of Iran. (Mojhed Hakemi Vala, 2011)[11]

Figure 3.19

Figure 3.20

Figure 3.21

11 https://www.researchgate.net/publication/230775467

3.7.1.2 Alcea kurdica

Family: Malvaceae

Distribution: Iran, Iraq, Turkey

Height: 110-150 cm

Flowering period: June-October

Blooming color: Lemon yellow

Flower shape and texture:

Large and radial symmetrical flowers

Leaves shape and texture:
Leaf blade is egg-shaped and deeply divided, the blade margin is serrated.

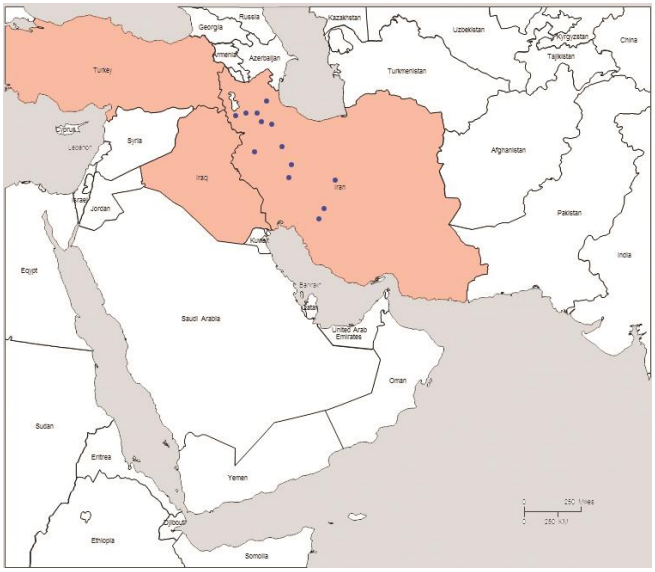


Figure 3.22: Distribution of *Alcea kurdica*

Form of growing: They form a rosette and long upright, more or less unbranched stems which end with the inflorescence.

The genus named *Alcea* has more than 50 species, mainly in south west and central Asia, 5 of them can be found in Iran, Iraq and Kurdistan as wild plants with high potential for gardening. *Alcea kurdica* is a perennial about 120-150cm tall which mostly grows in mountain slopes on limestone. *Alcea kurdica* can be found also in Cyprus, Syria, Lebanon and Afghanistan. (University of Sulaimani, Department of biology 2010)[12]

Figure 3.23

Figure 3.24

Figure 3.25, Figure 3.26

12 https://www.scribd.com/document/152918174/Alcea-kurdica

Perennials	Family	Persian name	Height (cm)	Blooming color	Origin
Astragalus Iranicus Bunge *	Fabaceae	Gavan-e-Beheshti	60	Bright purple	Iran
Asyneuma virgatum **	Campanulaceae	Gol Chaak	60	Violet	Iran, Armenia, Lebannon, Turkey
Imperata cylindrica 'Red Baron'***	Poaceae	Zolf-e-Sheytan	40	Red -White bloom	South east of Asia (Japan)
Prangos ferulacea	Apiaceae	Jashir	110	Yellow	Iran, Afghanistan, Israel, Jordan
Plumbago europaea ***	Plumbaginaceae	Alaf-e-sorbi	90	Pink-Violet	Central Asia
Salvia hydrangea	Lamiaceae	Maryam Goli	50	Pink-Purple	Iran,Armenia, Turkey
Lepidium latifolium	Brassicaceae	……	90	White	Europe to central Asia
Salvia virgata	Lamiaceae	M.Goli Harz	80	Blue-Violet	Iran, C.Asia, SE. Europe
Sedum telephium 'Karfunkelstein'***	Crassulaceae	Naz Nazak	50	Pink-Red	Eurasia
Teucrium oliverianum **	Lamiaceae	Maryam Nokhodi	60	Purple	Iran, Iraq, Kuwait

Table 24: Selected companion perennials

* *Astragalus Iranicus Bunge* need to be observed for difficulty of cultivation.

** Other native alternatives for *Asyneuma virgatum* and *Teucrium oliverianum* are *Asyneuma persicum* and *Teucrium persicum* but duo to lack of enough information about them these species are selected for trials.

*** According to author's findings, *Imperata cylindrica 'Red Baron', Plumbago europaeaand Sedum telephium 'Karfunkelstein' are* not native of Iran but they can be found commonly in the area of study. (They need to be observed in the mixtures)

3.7.2.1 Salvia hydrangea

Family: Lamiaceae

Distribution: Iran, Armenia, Turkey

Height: 40-50 cm

Flowering period: June-September

Blooming color: Pink-Purple

Flower shape and texture:

Large purplish pink flower along the stem

Leaves shape and texture:
Green leaf, lobed, widened at the base

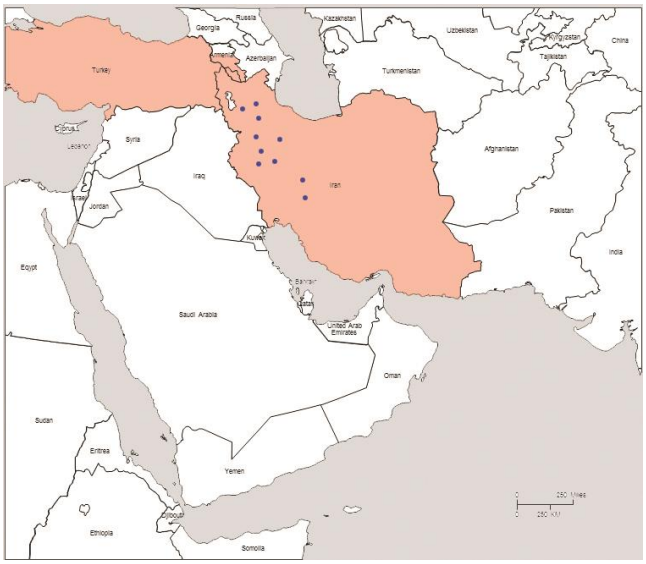


Figure 3.27: Distribution of *Salvia hydrangea*

Form of growing: The leaves are concentrated on lower part of plant at the base and large purplish-pink flowers are formed along vertical, upright, leafless stems at regular intervals.

Salvia genus geographically distributed all over the world, 58 species can be found in Iran while 17 of them are native of Iran. The main concentration of *Salvia hydrangea* in Iran is along the Zagros Mountains and the numbers of them increase by reaching to the northern parts of it.[13]

Figure 3.28, Figure 3.29

Figure 3.30

Figure 3.31, Figure 3.32

13 https://www.civilica.com/Paper-HERBAL01-HERBAL01_951.html

3.7.2.2 Prangos ferulacea

Family: Apiaceae

Distribution: Iran, Afghanistan, Israel, Jordan, Turkey, Syria

Height: 80-120 cm

Flowering period: March-July

Blooming color: Pale Yellow

Flower shape and texture:
Cover all plant in peak blooming

Leaves shape and texture:
The leaf arrangement is alternate (one leaf per node), dissected type

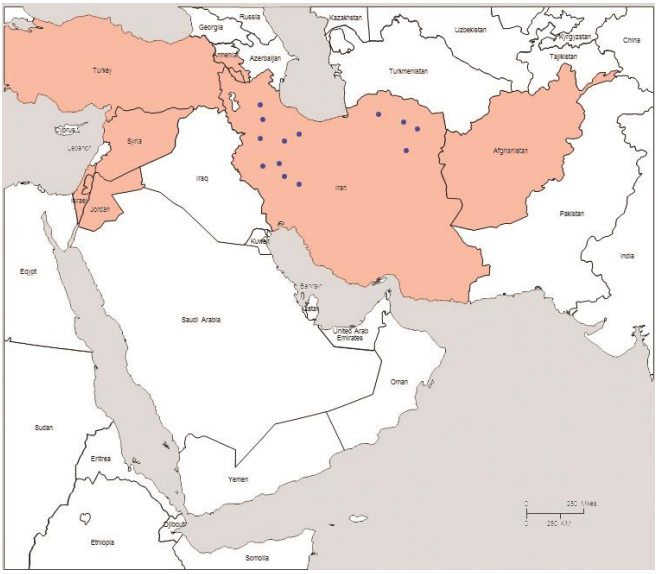


Figure 3.33: Distribution of *Prangos ferulacea*

Form of growing: Create rosette form and during blooming time flowers cover the whole surface with hemisphere-shape (similar to cushion form) arrangement.[14]

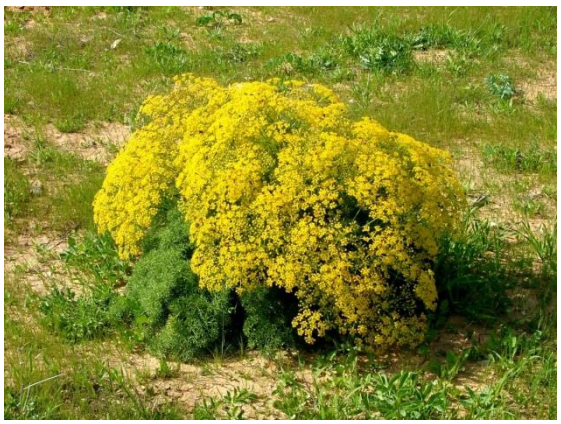


Figure 3.34

Figure 3.35

Figure 3.36

Figure 3.37

14 http://flora.org.il/en/plants/prafer/
http://www.flowersinisrael.com/Prangosferulacea_page.htm

Perennials	Family	Persian name	Height (cm)	Blooming color	Origin
Ajuga chamaecistus	Lamiaceae	Labdisi	40	Pink	Iran, Afghanistan
Astragalus kirrindicus *	Fabaceae	Gavan	40	Pale Yellow	Iran
Campanula glomerata	Campanulaceae	Gol-e-Estekani	65	Dark Violet	Iran, Europe toMongolia, Caucasus
Alcea aucheri	Malvaceae	Khatmi	40	Whity Pink	Iran
Glaucium oxylobum	Papaveraceae	Shaghayegh	35	Orange-Red	Iran, Israel
Arabis aubrietioides ***	Brassicaceae	……..	20	Rose-Purple	Turkey
Hypericum helianthemoides **	Hypericaceae	Hezar Cheshm, Chayi	40	Light Yellow	Iran, Iraq, Turkey
Aethionema grandiflorum	Brassicaceae	Atasheen	25	Pink	Iran, Iraq, Turkey
Ferula behboudiana	Apiaceae	Anghooze, Barijeh	90	Yellow	Iran, Afghanistan
Panicum virgatum ***	Poaceae	Chaman Torke	80	Green-Brown	North america
Dianthus orientalis	Caryophyllaceae	Mikhak	40	Pale Pink	Iran, Turkey, Pakistan
Ranunculus asiaticus	Ranunculaceae	Alale Irani	35	Wide range	Iran, Israel, Greece

Table 25: Selected filler perennials

* *Astragalus kirrindicus* need to be observed for difficulty of cultivation.

** Other native alternatives for *Hypericum helianthemoides* are *Hypericum asperulum* and *Hypericum scabrum* with similar shape and charactristics.

*** According to author's findings, *Arabis aubrietioides and Panicum virgatum are* not native of Iran but they can be found commonly in the area of study.

3.7.3.1 Glaucium oxylobum

Family: Papaveraceae

Distribution: Iran, Israel, Turkmenistan, Afghanistan, Pakistan, Syria, Lebanon, Iraq and small parts of Turkey

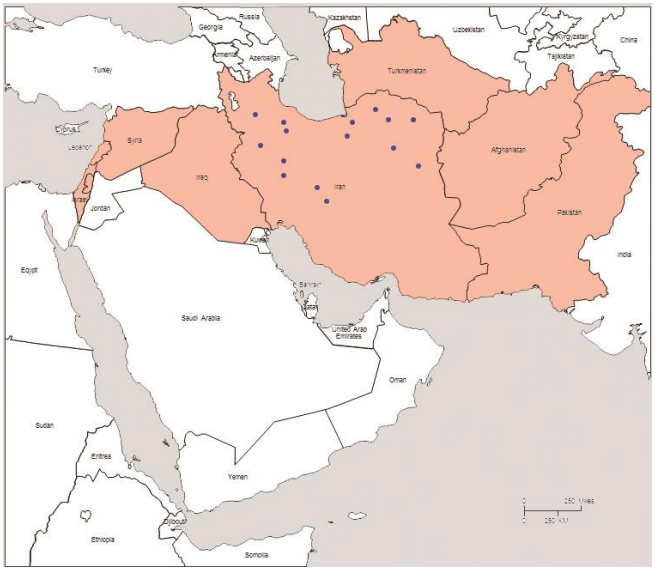


Figure 3.38: Distribution of *Glaucium oxylobum*

Height: 20-40 cm

Flowering period: May-August

Blooming color: Orange-Red with black spot at the center.

Flower shape and texture:
They have hermaphroditic, sinuous, radial-symmetrical flowers in the calyx and crown and wide and round 4 petals with over-lapping edges.

Leaves shape and texture:
Hairy lobed leaves, opposite with dissected shape and dentate or serrate margin.

Form of growing: They form rosette and the alternating foliage leaves are usually lobed.

The genus Glaucium named "Shaghayegh" or "Lale Koohi" in Persian contains about 25 species native to Europe, north Africa, southwest and central Asia of which 19 species are found in Iran.[15]



Figure 3.39, Figure 3.40

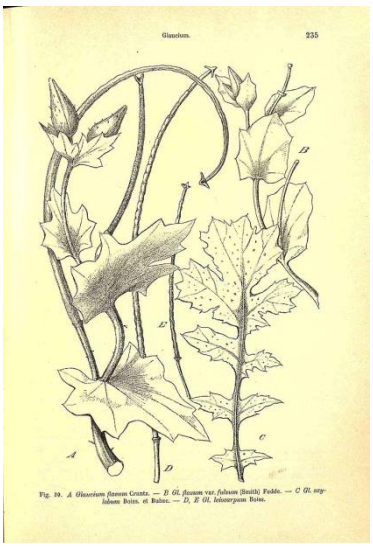


Figure 3.41



Figure 3.42, Figure 3.43

15 http://www.flowersinisrael.com/Glauciumoxylobum _page.htm
Book 'Antifungal Metabolites from plants' (Mehdi Razzaghi, Mahendra Rai 2013)

3.7.3.2 Dianthus orientalis

Family: Caryophyllaceae

Distribution: Iran, Turkey, Pakistan

Height: 15-45cm

Flowering period: May-August

Blooming color: Pale Pink

Flower shape and texture:
Flowers are solitary have 5 petals with frilled or pinked margin.

Leaves shape and texture:
Blue-green leaves are opposite, linear and simple.

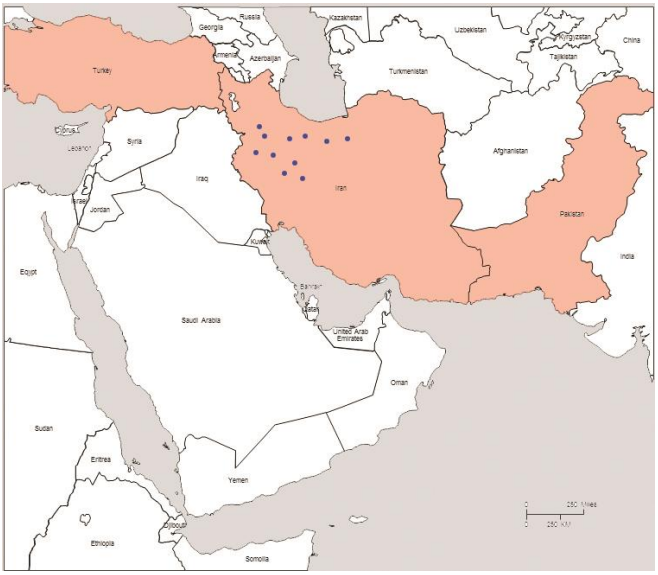


Figure 3.44: Distribution of *Dianthus orientalis*

Form of growing: Create a form similar to cushion (hemisphere) but with direct protruding branches centered on hemisphere.

Dianthus orientalis in Persian culture is a sign of admire, honor, excellence and attractiveness. In addition to mentioned places, *Dianthus orientalis* can be found with less distribution in Afghanistan, Syria and Turkmenistan.[16]

Figure 3.45, Figure 3.46

Figure 3.47

Figure 3.48, Figure 3.49

16 http://www.efloras.org/florataxon.aspx?flora_id=5&taxon_id=242000510

3.7.4 Bulbous

Perennials	Family	Persian name	Height (cm)	Blooming color	Origin
Allium atroviolaceum	Amaryllidaceae	Valak, Sir	70	Purple, Red-Violet	Iran, Iraq, Afghanistan, Turkey,….
Allium hollandicum	Amaryllidaceae	Piyaze Irani	80	Violet-Lavender	Iran, Kyrgyzstan
Allium stipitatum	Amaryllidaceae	Mooseer	90	White	Iran, Iraq, Afghanistan, Turkey,….
Fritillaria imperialis *	Liliaceae	Laleh Vajgoon-Ashke Maryam	100	Orange, Yellow	Iran,Iraq,Turkey, Afghanistan, Pakistan
Scilla persica	Asparagaceae	Najm-e-Abi-e-Irani	30	Bright Mid-Blue	Iran, Iraq, Turkey
Fritillaria persica *	Liliaceae	Laleh Vajgoon-e-Irani	90	Violet-Brown, Yellow	Iran, Iraq, Turkey, Syria, Israel
Narcissus tazetta	Amaryllidaceae	Narges	50	White, Yellow corona	Wide spread
Ixiolirion tataricum	Ixioliriaceae	Khiarak	40	Violet-Blue	Iran,Iraq, Turkey, Afghanistan,Syria,…
Ornithogalum persicum	Asparagaceae	Shirmorgh-e-Irani	50	White	Iran, Iraq, Turkey
Muscari constrictum	Asparagaceae	Sonbolak, Kalaghak	50	Dark Violet	SW Asia, Europe, N Africa
Iris persica	Iridaceae	Zanbagh-e-Irani	15	Pale Pink	Iran, Iraq, Turkey, Syria
Iris caucasica	Iridaceae	Zanbagh-e-Ghafghazi	15	Bright Yellow	Iran, Israel, Turkey, Armenia, Azarbaijan
Puschkinia scilloides	Asparagaceae	Najm-e-Abi saan	20	White to Pale Blue	Iran, Turkey, Lebanon, Caucasus

Table 26: Selected bulbous perennials

* *Fritillaria imperialis* and *Fritillaria persica* need to be observed for difficulty of cultivation.

3.7.4.1 Allium hollandicum

Family: Amaryllidaceae

Distribution: Iran, Kyrgyzstan but widely cultivated all over the world

Height: 50-90 cm

Flowering period: May-July

Blooming color: Violet-Lavender

Flower shape and texture:
Small star-shaped deep-purple flowers forming a wide globe-shaped cluster

Leaves shape and texture:
Narrow and short blue-green cylindrical basal leaves.

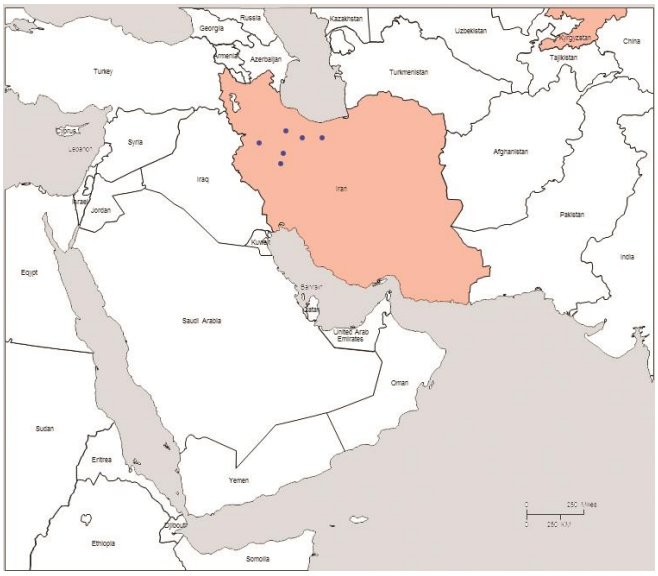


Figure 3.50: Distribution of *Allium hollandicum*

Form of growing: Forms short basal leaves dying down by flowering time with long leafless stem which end up with small star-shaped flowers in crowded spherical umbels.

Allium hollandicum awarded the prestigious "Award of Garden Merit" by the Royal Horticultural Society (RHS). Genus Allium has more than 600 species which 70 of them can be found in Iran. *Allium hollandicum* is native in Iran and Kyrgyzstan but because of its ornamental value it is widely cultivated all over the world.[17]

Figure 3.51

Figure 3.52

Figure 3.53, Figure 3.54

17 http://www.seedaholic.com/allium-aflatunense-purple-sensation.html

3.7.4.2 Ixiolirion tataricum

Family: Ixioliriaceae

Distribution: Iran, Iraq, Turkey, Afghanistan, Pakistan, Syria

Height: 20-40 cm

Flowering period: April-June

Blooming color: Violet-Blue

Flower shape and texture:
Start funnel-shaped then open into star-shaped flowers arranged in columns

Leaves shape and texture:
Simple dark-green leaves, linear and full-rim

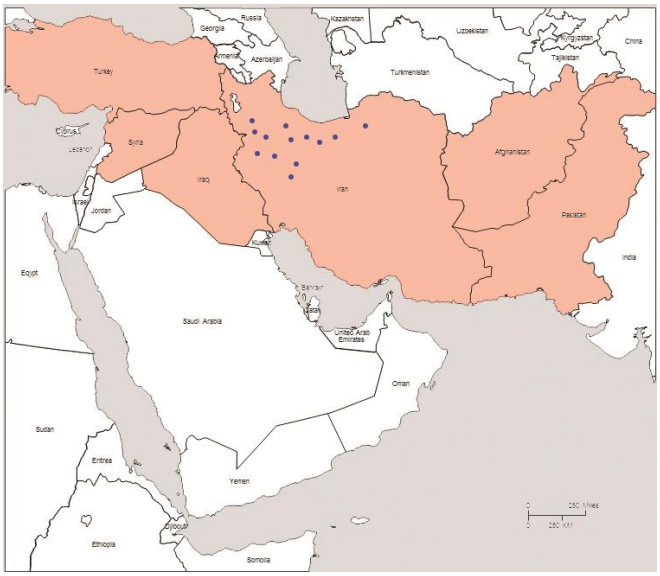


Figure 3.55: Distribution of *Ixiolirion tataricum*

Form of growing: Form more or less leaf rosettes which are arranged alternately and spirally then grow as upright with one main stem dividing into several narrow stems reaching up to 40 cm with relatively large flowers.[18]

Figure 3.56, Figure 3.57

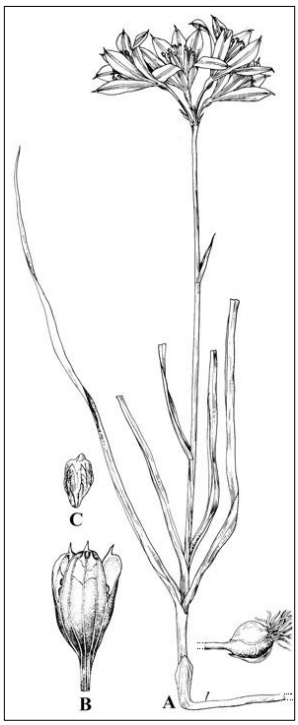


Figure 3.58

Figure 3.59, Figure 3.60

18 http://www.efloras.org/florataxon.aspx?flora_id=2&taxon_id=200028050
https://www.johnscheepers.com/ixiolirion-pallasii.html

3.7.4.3 Ornithogalum persicum

Family: Asparagaceae

Distribution: Iran, Iraq, Turkey

Height: 30-60 cm

Flowering period: June-September

Blooming color: White

Flower shape and texture:
Raceme (flower cluster) cylindrical,
Many flowered, dense while flowering

Leaves shape and texture:
Simple long linear basal leaves with
Smooth margin, lance-shaped

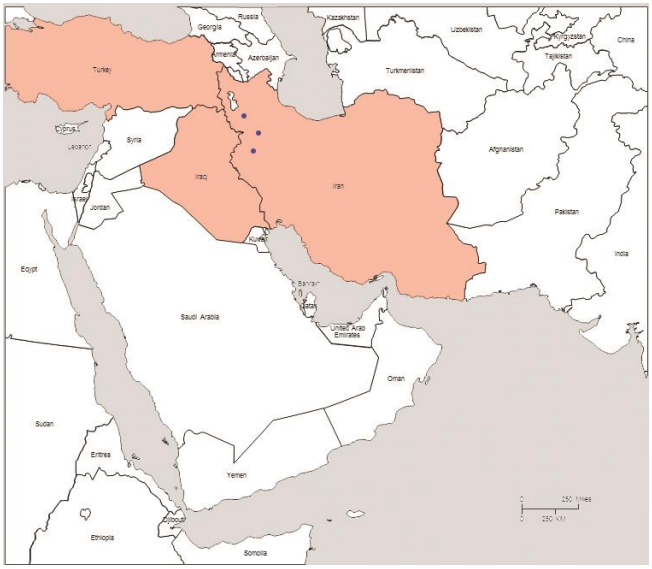


Figure 3.61: Distribution of *Ornithogalum persicum*

Form of growing: Leaves closely overlapping at base long up right stem reach to 60 cm with raceme at the top (a flower cluster with the separate flowers attached by short equal stalks at equal distances along a central stem. The flowers at the base of the central stem develop first).[19]

Genus *Ornithogalum* contains more than 200 species mostly native of southern Europe and Southern Africa which 13 of them can be found in Iran.

Figure 3.62, Figure 3.63

Figure 3.64

Figure 3.65

19 https://www.gbif.org/species/2773426
http://www.turkiyebitkileri.com/index.php?dil=en&id=2&familya=154&cins=886&tur=4698#.WbmftWCzDc

Perennials	Family	Persian name	Height (cm)	Blooming color	Origin
Ground Covers					
Campanula aucheri	Campanulaceae	Gol-e-Estekani	10	Violet-Blue	Iran, Iraq, Turkey, Caucasus, Armenia
Stachys lavandulifolia	Lamiaceae	Aroos-e-Kouhi, Chay-e-Kouhi	15	Dark Pink	Iran, Caucasus, Iraq, Turkey, USA
Aubrieta parviflora	Brassicaceae	Oubrita	15	Pale lilac	Iran, Turkey, Iraq, Southern Europe
Stachys persica	Lamiaceae	Sonboleyi-e-Irani	15	Light Pink	Iran
Arabis caucasica 'Snow hood'	Brassicaceae	Sabad-e-Noghreyi	10	White	Iran, Central Asia, Southern Europe
Teucrium ackermannii **	Lamiaceae	Maryam Nokhodi, Kalpooreh	15	Pink	Iran, Mediterranean climate countries
Cushion forms					
Acanthophyllum pungens	Caryophyllaceae	Choobak	30	Light Pink	Iran, Afghanistan, Kazakhstan, Mongolia
Astragalus angustifolius *	Fabaceae	Gavan	40	White	Iran, Turkey, Caucasus, Syria
Onobrychis cornuta	Fabaceae	Spers-e-Poshteyi	50	Reddish Purple	Iran, Afghanistan, Pakistan, Turkey, Syria, Israel, Armenia

Table 27: Selected ground cover and cushion form perennials

* *Astragalus angustifolius* needs to be observed for difficulty of cultivation.

** Other native alternative for *Teucrium ackermannii* is *Teucrium persicum* but duo to lack of enough information about it this species is selected for trials.

3.7.5.1 Stachys lavandulifolia

Family: Lamiaceae

Distribution: Iran, Caucasus,Iraq, Turkey

Height: 10-20 cm

Flowering period: May-July

Blooming color: Dark Pink

Flower shape and texture:
Petal inflorescences (cluster),
Fluffy, silky and noticeably hairy flowers

Leaves shape and texture:
Grey-green, narrow leaves covered
in long, silky hairs, lanceolate (sharp head)

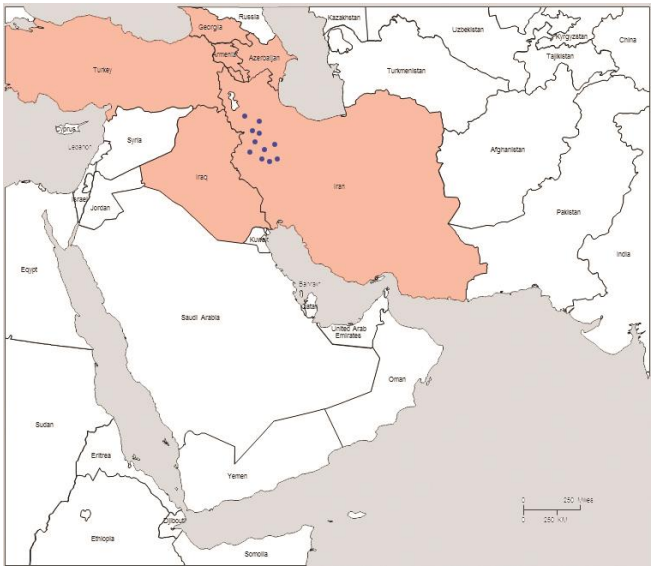


Figure 3.66: Distribution of *Stachys lavandulifolia*

Form of growing: Form basal rosettes with creeping shoots, from the stem to the end is covered with very small leaves mixed with silky flowers similar to a hairy carpet.[20]

The genus *Stachys*, one of the largest genera of the Lamiaceae family, includes about 300 species. More than 39 species of this genus are grown and distributed in various regions of Iran. *Stachys lavandulifolia* is a native plant that is widely distributed in Zagros Mountains and known as chay-e-kouhi (Mountain tee).[21]

Figure 3.67

Figure 3.68

Figure 3.69

Figure 3.70

20 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4698131/
21 Rechinger KH, Hedge IC. Flora Iranica. Graz Austria: Akademiche Druck Verlagsanstalt; 1982. pp. 359-361.

3.7.5.2 Onobrychis cornuta

Family: Fabaceae

Distribution: Iran, Afghanistan, Pakistan, Turkey, Syria, Israel, Armenia

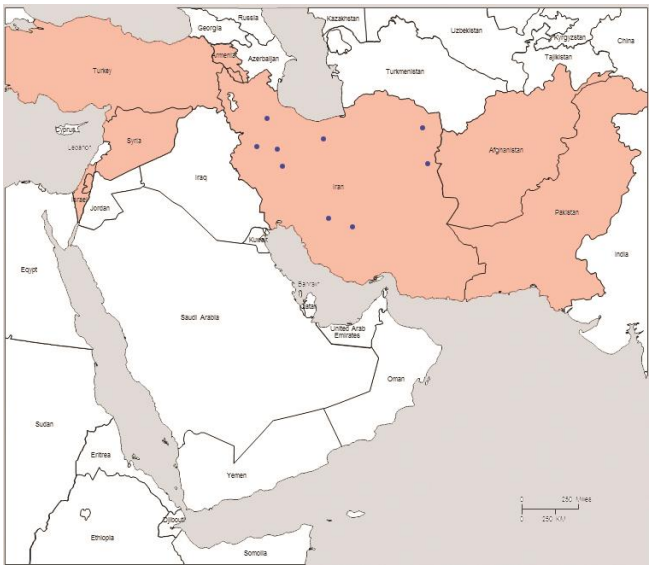


Figure 3.71: Distribution of *Onobrychis cornuta*

Height: 30-60 cm

Flowering period: May-September

Blooming color: Reddish Purple, Pink

Flower shape and texture:
Long inflorescence stem contain 2-5 small flowers.

Leaves shape and texture:
Linear lanceolate leaves covered in short soft hair on both sides, alternate leaf (one node per leaf) stands opposite each other.

Form of growing: Forming cushion or tufts up to 60 cm in height and diameter covered in reddish purple flowers from mid-spring to early autumn.

Presently 150 species of *Onobrychis* are known all over the world which 56 species of them can be found in Iran and 27 of them are native in Iran.[22]

Figure 3.72, Figure 3.73

Figure 3.74, Figure 3.75

22 Book "Flora of Silk Road" (Christopher Gardner, Bashak Gardner)
Book "Flora of Ilam" (V.Mozafarian 2013)

3.8 Perennial mixtures

Three suggested perennial mixtures in this part are mixes as a basis for trial plantings and these proposal lists of plants need to be observed from 3 to 5 years and then from the result there is a possibility to find a combination which can function for city landscaping in selected area.

Figure 3.76; Combination of *Eremurus persicus* and *Onobrychis cornuta* in nature of Iran applied in 'Cushion Mixture'

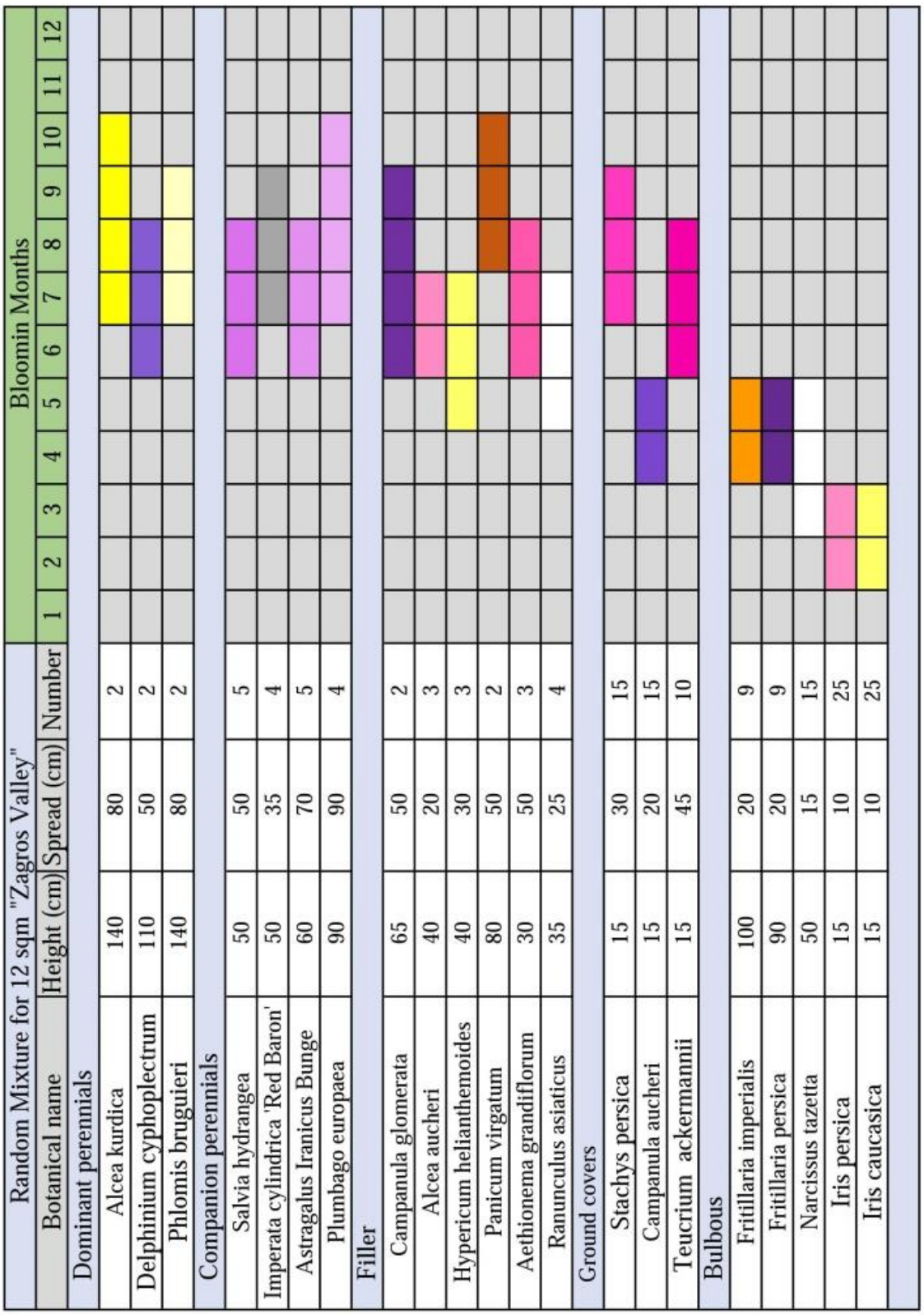
Figure 3.77; Combination of *Crambe orientalis* and *Glaucium* in nature of Iran applied in 'Random Mixture' (Zagros Bride)

3.8.1 Cushion Mixture "Zagros Summer"

Cushion Mixture for 12 sqm "Zagros Summer"				Bloomin Months											
Botanical name	Height (cm)	Spread (cm)	Number	1	2	3	4	5	6	7	8	9	10	11	12
Dominant perennials															
Eremurus persicus	80	40	5												
Asphodeline lutea	110	30	4												
Campanula bononiensis	90	40	4												
Companion perennials															
Prangos ferulacea	80	80	4												
Bulbous															
Allium hollandicum	80	30	15												
Allium stipitatum	90	30	15												
Ixiolirion tataricum	40	15	20												
Ornithogalum persicum	50	15	20												
Cushion form perennials															
Onobrychis cornuta	50	60	5												
Astragalus angustifolius	40	50	4												
Acanthophyllum pungens	30	40	4												

Table 28: Cushion Mixture (Zagros Summer)

3.8.2 Mixture "Zagros Valley"



Random Mixture for 12 sqm "Zagros Valley"				Bloomin Months											
Botanical name	Height (cm)	Spread (cm)	Number	1	2	3	4	5	6	7	8	9	10	11	12
Dominant perennials															
Alcea kurdica	140	80	2												
Delphinium cyphoplectrum	110	50	2												
Phlomis bruguieri	140	80	2												
Companion perennials															
Salvia hydrangea	50	50	5												
Imperata cylindrica 'Red Baron'	50	35	4												
Astragalus Iranicus Bunge	60	70	5												
Plumbago europaea	90	90	4												
Filler															
Campanula glomerata	65	50	2												
Alcea aucheri	40	20	3												
Hypericum helianthemoides	40	30	3												
Panicum virgatum	80	50	2												
Aethionema grandiflorum	30	50	3												
Ranunculus asiaticus	35	25	4												
Ground covers															
Stachys persica	15	30	15												
Campanula aucheri	15	20	15												
Teucrium ackermannii	15	45	10												
Bulbous															
Fritillaria imperialis	100	20	9												
Fritillaria persica	90	20	9												
Narcissus tazetta	50	15	15												
Iris persica	15	10	25												
Iris caucasica	15	10	25												

Table 29: Random Mixture (Zagros Valley)

3.8.3 Mixture "Zagros Bride"

Random Mixture for 12 sqm "Zagros Bride"				Bloomin Months											
Botanical name	Height (cm)	Spread (cm)	Number	1	2	3	4	5	6	7	8	9	10	11	12
Dominant perennials															
Crambe orientalis	110	90	2												
Calamagrostis x acutiflora	140	80	2												
Eremostachys laciniata	80	50	2												
Eremurus spectabilis	80	40	2												
Companion perennials															
Asyneuma virgatum	60	40	5												
Lepidium latifolium	90	50	5												
Salvia virgata	80	70	3												
Sedum telephium 'Karfunkelstein'	50	40	5												
Teucrium oliverianum	60	50	4												
FIller															
Glaucium oxylobum	35	20	3												
Arabis aubrietioides	20	15	4												
Ferula behboudiana	90	30	3												
Dianthus orientalis	40	40	3												
Astragalus kirrindicus	40	40	3												
Ground covers															
Stachys lavandulifolia	15	40	15												
Arabis caucasica 'Snow hood'	10	40	15												
Aubrieta parviflora	15	35	15												
Bulbous															
Allium atroviolaceum	70	25	12												
Puschkinia scilloides	20	10	25												
Ornithogalum persicum	50	20	15												
Muscari constrictum	50	20	15												
Scilla persica	30	10	20												

Table 30: Random Mixture (Zagros Bride)

3.9 Overview and recommendation for future

In this thesis, Bernburg perennial mixture project, applied method in it with brief analysis has been presented as a successful sample for implementation of perennial mixtures and data collection with a potential to be generalized with slight changes in different climatic zones and geographical features.

Bernburg perennial mixture project is a proper sample which is carried out and supervised by Prof. Dr. Wolfram Kircher during many years and in this period of time many parameters have been experimented and many successful results are obtained and recorded.

In this thesis has been tried to create a manual guidance for perennial planting in order to prepare the basis for starting similar research project in Iran with great ecological potential and in this process 3 perennial mixes are introduced as trial planting with native perennials of the west of Iran as start point of this operation.

One of recommended ways to create similar projects in Iran is taking the initiative of academic and research places such as universities which are pioneers in the field of scientific growth and successful development of countries in all over the world, in the same vein creating a partnership between universities of Iran and abroad scientific places can help significantly to start and develop research projects and Anhalt University of Applied Sciences with appropriate background in partnership with abroad universities has the capacity and readiness for this.

APPENDIX 1

Aesthetic Monitoring 2016 Bernburg

		Number of monitorer	1		2		3		4		5		6		7		8			
Date	May 2016		23/5		23/5		23/5		23/5		20/5		24/5		24/5		24/5			
		Monitorer	Ilka Ballerstein		Jessica Fenzl		Thomas Zlobinski		Andy Engelke		Daniela Jürges		Mahziar Gharavi		Elio Gama		Besmir Hasanaj		Average	
Number	Mixture	Substrate	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW
S1-A-1-x	Flower Haze	Gravel	4	3	4	4	3	2	6	3	4	3	5	5	3	3	4	4	4.1	3.4
S1-B-1-x	Prairie	Gravel	3	3	4	2	3	2	4	4	4	2	4	3	1	1	3	2	3.3	2.4
S1-C-1-x	Moist Site	Gravel	1	1	1	1	1	1	4	4	1	1	3	1	1	1	1	1	1.6	1.4
S2-A-1-x	Flower Haze	Sandy	7	8	7	8	9	9	9	9	9	9	8	7	7	5	6	6	7.8	7.6
S2-B-1-x	Prairie	Sandy	7	5	9	7	7	7	6	6	9	5	7	7	5	5	3	3	6.6	5.6
S2-C-1-x	Moist Site	Sandy	7	6	8	8	6	4	6	5	7	6	6	5	5	3	2	3	5.9	5.0
S3-A-1-x	Flower Haze	Topsoil	6	7	7	8	6	5	7	8	6	6	7	6	5	3	5	4	6.1	5.9
S3-B-1-x	Prairie	Topsoil	6	5	8	7	5	5	5	6	6	3	6	6	3	3	3	3	5.3	4.8
S3-C-1-x	Moist Site	Topsoil	5	6	7	8	4	4	6	6	6	5	6	5	3	5	2	2	4.9	5.1
S1-A-2-a	Flower Haze	Gravel	6	6	8	7	5	4	6	6	6	7	7	7	3	5	4	5	5.6	5.9
S1-B-2-a	Prairie	Gravel	5	6	8	7	4	4	7	5	6	3	5	5	3	3	3	3	5.1	4.5
S1-C-2-a	Moist Site	Gravel	1	1	4	3	1	1	3	4	1	1	3	4	1	1	2	2	2.0	2.1
S2-A-2-a	Flower Haze	Sandy	9	9	9	9	9	8	6	5	9	9	7	7	5	7	5	4	7.4	7.3
S2-B-2-a	Prairie	Sandy	8	6	8	7	8	7	5	5	9	5	8	8	7	7	4	5	7.1	6.3
S2-C-2-a	Moist Site	Sandy	7	7	9	9	6	6	6	7	6	6	6	7	3	5	4	4	5.9	6.4
S3-A-2-a	Flower Haze	Topsoil	6	5	7	8	5	3	7	8	5	5	6	7	3	5	3	2	5.3	5.4
S3-B-2-a	Prairie	Topsoil	6	5	7	7	3	2	7	6	4	2	5	6	3	1	2	3	4.6	4.0
S3-C-2-a	Moist Site	Topsoil	4	4	7	7	3	2	6	7	4	3	5	5	1	3	2	2	4.0	4.1
S1-A-2-b	Flower Haze	Gravel	6	6	7	7	4	3	6	7	6	6	6	7	5	5	3	2	5.4	5.4
S1-B-2-b	Prairie	Gravel	5	5	7	6	3	3	6	6	5	2	5	4	3	3	2	2	4.5	3.9
S1-C-2-b	Moist Site	Gravel	1	1	3	2	1	1	4	4	1	1	3	3	1	1	2	2	2.0	1.9
S2-A-2-b	Flower Haze	Sandy	9	8	9	9	9	9	6	5	9	9	8	8	9	9	6	7	8.1	8.0
S2-B-2-b	Prairie	Sandy	8	6	8	7	8	7	5	4	9	5	7	7	9	7	4	4	7.3	5.9
S2-C-2-b	Moist Site	Sandy	7	7	7	7	7	7	8	9	9	9	9	8	7	9	6	4	7.5	7.5
S3-A-2-b	Flower Haze	Topsoil	5	5	7	7	4	3	7	6	4	3	6	6	3	1	2	2	4.8	4.1
S3-B-2-b	Prairie	Topsoil	6	5	7	7	3	2	5	5	5	2	6	6	3	3	2	3	4.6	4.1
S3-C-2-b	Moist Site	Topsoil	5	5	7	7	3	2	7	8	4	3	7	6	3	1	2	2	4.8	4.3
S1-A-2-c	Flower Haze	Gravel	6	6	6	6	4	4	6	7	5	6	7	7	3	3	3	2	5.0	5.1
S1-B-2-c	Prairie	Gravel	5	5	6	6	3	3	4	4	4	2	4	4	3	1	2	3	3.9	3.5
S1-C-2-c	Moist Site	Gravel	1	1	3	1	1	1	3	3	1	1	2	2	1	1	2	2	1.8	1.5
S2-A-2-c	Flower Haze	Sandy	9	8	9	9	9	9	7	7	9	9	7	8	9	9	8	9	8.4	8.5
S2-B-2-c	Prairie	Sandy	8	6	9	8	8	7	5	4	9	5	6	7	7	5	5	6	7.1	6.0
S2-C-2-c	Moist Site	Sandy	7	6	8	8	6	5	7	8	6	6	7	7	5	3	4	4	6.3	5.9
S3-A-2-c	Flower Haze	Topsoil	5	5	7	8	6	5	7	8	6	6	7	7	5	7	3	4	5.8	6.3
S3-B-2-c	Prairie	Topsoil	6	5	8	7	4	3	7	7	6	2	7	6	7	5	3	3	6.0	4.8
S3-C-2-c	Moist Site	Topsoil	4	4	6	7	3	2	7	8	3	2	6	5	3	5	2	2	4.3	4.4

		Number of monitorer:	1				2		3		4		5							
Date	June 2016		16/6				16/6		16/6		20/6		17/6							
		Monitorer	Ilka Ballerstein		Jessica Fenzl		Thomas Zlobinski		Andy Engelke		Daniela Jürges		Tim (Intern)						Average	
Nummer	Mischung	Substrat	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW
S1-A-1-x	Flower Haze	Gravel	4	5			5	3	6	6	5	7	5	5					5	5.2
S1-B-1-x	Prairie	Gravel	4	4			5	4	5	5	5	5	4	3					4.6	4.2
S1-C-1-x	Moist Site	Gravel	1	1			1	1	1	1	1	1	2	1					1.2	1
S2-A-1-x	Flower Haze	Sandy	8	8			9	9	8	9	9	9	6	7					8	8.4
S2-B-1-x	Prairie	Sandy	7	6			7	8	5	4	9	8	6	4					6.8	6
S2-C-1-x	Moist Site	Sandy	7	6			4	4	5	5	7	5	5	3					5.6	4.6
S3-A-1-x	Flower Haze	Topsoil	8	8			6	7	6	7	7	7	5	6					6.4	7
S3-B-1-x	Prairie	Topsoil	7	6			5	5	6	4	7	6	6	5					6.2	5.2
S3-C-1-x	Moist Site	Topsoil	6	6			4	3	6	7	5	6	4	3					5	5
S1-A-2-a	Flower Haze	Gravel	8	8			4	5	6	7	6	7	5	7					5.8	6.8
S1-B-2-a	Prairie	Gravel	8	7			4	4	6	5	6	6	5	4					5.8	5.2
S1-C-2-a	Moist Site	Gravel	2	1			1	1	4	6	3	3	1	1					2.2	2.4
S2-A-2-a	Flower Haze	Sandy	8	8			7	6	6	7	9	8	7	7					7.4	7.2
S2-B-2-a	Prairie	Sandy	8	8			8	7	6	7	9	9	7	7					7.6	7.6
S2-C-2-a	Moist Site	Sandy	7	7			6	5	7	8	9	8	6	7					7	7
S3-A-2-a	Flower Haze	Topsoil	6	5			4	4	6	7	5	6	3	3					4.8	5
S3-B-2-a	Prairie	Topsoil	6	5			3	3	5	5	5	5	3	2					4.4	4
S3-C-2-a	Moist Site	Topsoil	5	5			3	3	6	7	4	6	3	2					4.2	4.6
S1-A-2-b	Flower Haze	Gravel	8	7			5	6	7	8	5	6	6	5					6.2	6.4
S1-B-2-b	Prairie	Gravel	8	8			3	2	6	5	5	5	4	3					5.2	4.6
S1-C-2-b	Moist Site	Gravel	2	1			1	1	4	6	2	2	1	1					2	2.2
S2-A-2-b	Flower Haze	Sandy	8	8			8	8	6	5	9	9	4	5					7	7
S2-B-2-b	Prairie	Sandy	8	7			7	7	5	4	9	8	4	3					6.6	5.8
S2-C-2-b	Moist Site	Sandy	4	3			3	2	5	6	5	4	2	3					3.8	3.6
S3-A-2-b	Flower Haze	Topsoil	6	7			5	6	7	7	5	5	5	5					5.6	6
S3-B-2-b	Prairie	Topsoil	7	7			4	3	5	5	5	5	3	3					4.8	4.6
S3-C-2-b	Moist Site	Topsoil	6	5			3	3	5	6	4	6	4	4					4.4	4.8
S1-A-2-c	Flower Haze	Gravel	6	5			4	4	8	8	4	6	5	5					5.4	5.6
S1-B-2-c	Prairie	Gravel	6	6			3	2	7	6	4	5	4	4					4.8	4.6
S1-C-2-c	Moist Site	Gravel	1	1			1	1	3	3	1	1	1	1					1.4	1.4
S2-A-2-c	Flower Haze	Sandy	8	7			6	6	8	8	8	9	6	6					7.2	7.2
S2-B-2-c	Prairie	Sandy	8	7			6	5	7	7	9	9	5	5					7	6.6
S2-C-2-c	Moist Site	Sandy	5	3			3	2	5	5	5	3	3	3					4.2	3.2
S3-A-2-c	Flower Haze	Topsoil	6	7			6	7	6	6	8	8	8	7					6.8	7
S3-B-2-c	Prairie	Topsoil	7	7			5	4	5	6	7	7	5	4					5.8	5.6
S3-C-2-c	Moist Site	Topsoil	6	5			3	2	5	6	4	4	4	3					4.4	4

		Number of monitorer:	1		2		3		4		5		6							
Date	July 2016		18/7				18/7		18/7		15/7		17/6							
		Monitorer	Ilka Ballerstein		Jessica Fenzl		Thomas Zlobinski		Andy Engelke		Daniela Jürges		Mahziar Gharavi						Average	
Nummer	Mischung	Substrat	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW
S1-A-1-x	Flower Haze	Gravel	5	4	5	4	6	6	4	4	6	7	3	3					4.8	4.7
S1-B-1-x	Prairie	Gravel	5	3	6	5	6	5	5	5	5	5	5	4					5.3	4.5
S1-C-1-x	Moist Site	Gravel	1	1	1	1	1	1	1	1	1	1	1	1					1.0	1.0
S2-A-1-x	Flower Haze	Sandy	7	7	8	7	6	7	6	7	8	7	7	8					7.0	7.2
S2-B-1-x	Prairie	Sandy	8	7	8	8	7	7	8	8	9	9	8	8					8.0	7.8
S2-C-1-x	Moist Site	Sandy	4	2	4	3	3	3	4	5	4	2	3	3					3.7	3.0
S3-A-1-x	Flower Haze	Topsoil	6	5	7	5	6	7	7	7	6	6	6	6					6.3	6.0
S3-B-1-x	Prairie	Topsoil	9	8	9	9	7	6	7	8	9	7	8	8					8.2	7.7
S3-C-1-x	Moist Site	Topsoil	4	2	3	3	4	3	3	3	4	3	4	3					3.7	2.8
S1-A-2-a	Flower Haze	Gravel	7	6	7	6	6	6	4	5	5	6	5	5					5.7	5.7
S1-B-2-a	Prairie	Gravel	7	7	8	8	5	5	6	6	6	7	6	5					6.3	6.3
S1-C-2-a	Moist Site	Gravel	2	1	2	1	2	2	1	1	2	1	2	3					1.8	1.5
S2-A-2-a	Flower Haze	Sandy	7	6	8	7	6	6	4	3	8	7	7	8					6.7	6.2
S2-B-2-a	Prairie	Sandy	9	8	8	9	6	5	5	5	9	9	9	9					7.7	7.5
S2-C-2-a	Moist Site	Sandy	7	6	7	7	4	5	6	6	7	5	8	7					6.5	6.0
S3-A-2-a	Flower Haze	Topsoil	5	4	5	5	5	4	4	4	5	3	6	4					5.0	4.0
S3-B-2-a	Prairie	Topsoil	7	6	7	8	3	3	6	7	5	5	6	5					5.7	5.7
S3-C-2-a	Moist Site	Topsoil	6	5	6	6	2	2	6	6	5	3	5	5					5.0	4.5
S1-A-2-b	Flower Haze	Gravel	7	6	7	6	5	6	3	3	4	5	5	6					5.2	5.3
S1-B-2-b	Prairie	Gravel	7	6	7	7	6	5	5	6	5	6	6	6					6.0	6.0
S1-C-2-b	Moist Site	Gravel	2	1	1	2	2	1	1	1	1	1	2	3					1.5	1.5
S2-A-2-b	Flower Haze	Sandy	6	6	6	6	7	8	6	7	8	8	8	8					6.8	7.2
S2-B-2-b	Prairie	Sandy	9	8	9	9	7	6	8	8	8	8	8	9					8.2	8.0
S2-C-2-b	Moist Site	Sandy	4	2	5	4	2	2	1	4	4	1	3	1					3.2	2.3
S3-A-2-b	Flower Haze	Topsoil	5	4	5	5	6	5	6	5	5	6	6	5					5.5	5.0
S3-B-2-b	Prairie	Topsoil	7	6	7	7	4	3	7	7	5	5	7	6					6.2	5.7
S3-C-2-b	Moist Site	Topsoil	6	5	6	5	2	1	2	3	4	2	5	4					4.2	3.3
S1-A-2-c	Flower Haze	Gravel	5	4	5	4	4	4	6	7	4	5	4	2					4.7	4.3
S1-B-2-c	Prairie	Gravel	6	6	5	6	5	5	6	7	4	5	5	4					5.2	5.5
S1-C-2-c	Moist Site	Gravel	2	1	1	1	2	2	1	1	1	1	1	1					1.3	1.2
S2-A-2-c	Flower Haze	Sandy	6	6	7	7	7	7	8	8	9	9	7	8					7.3	7.5
S2-B-2-c	Prairie	Sandy	9	8	9	9	7	7	6	7	9	9	7	7					7.8	7.8
S2-C-2-c	Moist Site	Sandy	4	2	6	5	3	3	5	5	4	3	4	2					4.3	3.3
S3-A-2-c	Flower Haze	Topsoil	6	5	7	6	6	7	7	8	7	8	7	7					6.7	6.8
S3-B-2-c	Prairie	Topsoil	7	7	8	8	4	3	7	8	7	8	7	7					6.7	6.8
S3-C-2-c	Moist Site	Topsoil	6	5	5	5	2	2	2	2	4	2	4	4					3.8	3.3

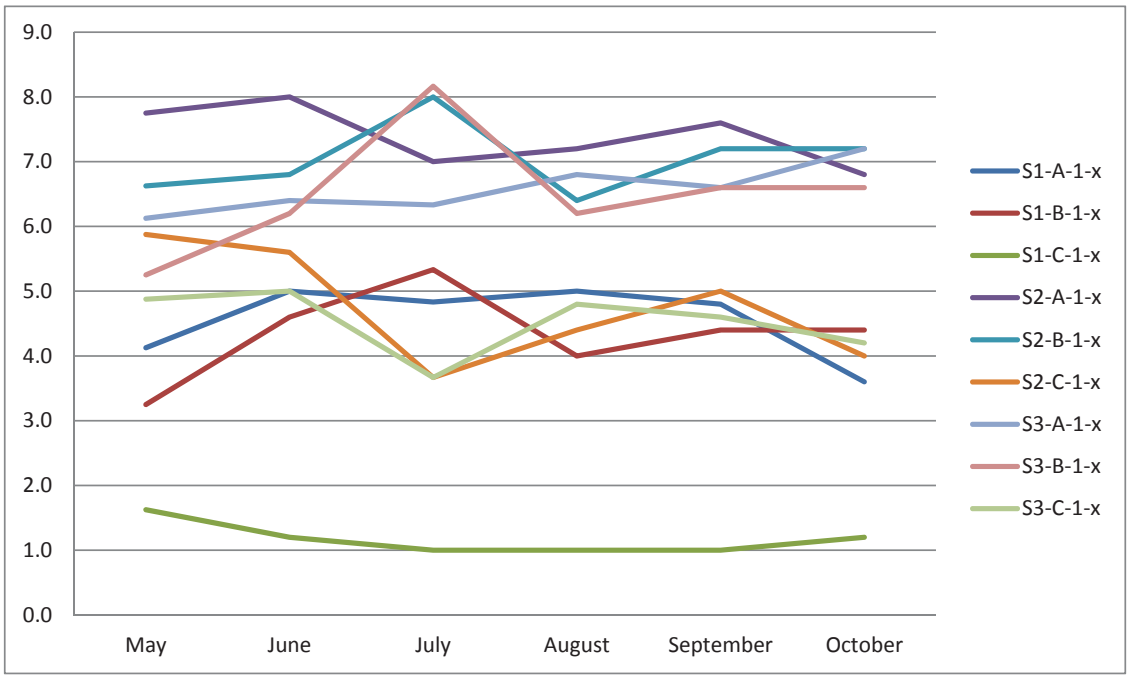
		Number of monitorer:	1		2		3		4		5				coverage 2016					
Date	August 2016		24.08		18.08		19.08		19.08		19/8				Ilka		Daniela			
		Monitorer	Ilka Ballerstein		Jessica Fenzl		Thomas Zlobinski		Andy Engelke		Daniela Jürges								Average	Average
Nummer	Mischung	Substrat	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	Deckungsgrad 16		Deckungsgrad 16		GE	SW	Coverage16
S1-A-1-x	Flower Haze	Gravel	5	5	5	4	4	4	7	8	4	5			5		5		5	5.2	5
S1-B-1-x	Prairie	Gravel	5	4	5	3	2	2	5	5	3	5			5		5		4	3.8	5
S1-C-1-x	Moist Site	Gravel	1	1	1	1	1	1	1	1	1	1			1		1		1	1	1
S2-A-1-x	Flower Haze	Sandy	7	7	7	7	5	6	8	9	9	9			9		9		7.2	7.6	9
S2-B-1-x	Prairie	Sandy	6	5	7	7	3	4	7	8	9	9			9		9		6.4	6.6	9
S2-C-1-x	Moist Site	Sandy	5	5	5	4	3	3	5	5	4	4			7		7		4.4	4.2	7
S3-A-1-x	Flower Haze	Topsoil	7	6	7	5	7	7	8	9	5	4			7		7		6.8	6.2	7
S3-B-1-x	Prairie	Topsoil	6	6	7	5	5	4	6	7	7	7			9		9		6.2	5.8	9
S3-C-1-x	Moist Site	Topsoil	5	5	6	5	3	4	7	7	3	4			6		7		4.8	5	6.5
																					Coverage 16
S1-A-2-a	Flower Haze	Gravel	7	7	7	6	6	5	5	5	5	7			8		9		6	6	8.5
S1-B-2-a	Prairie	Gravel	7	7	7	7	4	4	7	7	8	9			8		7		6.6	6.8	7.5
S1-C-2-a	Moist Site	Gravel	2	1	3	3	1	1	1	1	3	2			1		1		2	1.6	1
S2-A-2-a	Flower Haze	Sandy	7	7	8	7	7	7	8	8	8	8			9		9		7.6	7.4	9
S2-B-2-a	Prairie	Sandy	7	6	7	7	7	6	8	9	8	8			9		9		7.4	7.2	9
S2-C-2-a	Moist Site	Sandy	7	6	7	6	6	5	8	8	7	8			8		9		7	6.6	8.5
S3-A-2-a	Flower Haze	Topsoil	6	6	8	7	5	6	6	7	6	8			7		7		6.2	6.8	7
S3-B-2-a	Prairie	Topsoil	6	6	8	7	4	4	7	7	6	8			7		7		6.2	6.4	7
S3-C-2-a	Moist Site	Topsoil	6	6	8	7	4	3	9	9	5	5			5		5		6.4	6	5
																					Coverage16
S1-A-2-b	Flower Haze	Gravel	6	6	7	6	5	6	8	9	7	7			7		7		6.6	6.8	7
S1-B-2-b	Prairie	Gravel	6	6	7	7	4	3	6	7	5	7			6		7		5.6	6	6.5
S1-C-2-b	Moist Site	Gravel	2	1	2	1	1	1	1	1	2	1			1		1		1.6	1	1
S2-A-2-b	Flower Haze	Sandy	7	7	7	6	8	7	9	9	9	9			9		9		8	7.6	9
S2-B-2-b	Prairie	Sandy	7	6	6	6	6	6	7	8	9	9			9		9		7	7	9
S2-C-2-b	Moist Site	Sandy	4	4	5	5	4	3	6	6	5	3			7		7		4.8	4.2	7
S3-A-2-b	Flower Haze	Topsoil	6	6	7	7	6	6	6	6	5	8			7		7		6	6.6	7
S3-B-2-b	Prairie	Topsoil	7	6	7	7	5	4	7	8	6	8			6		5		6.4	6.6	5.5
S3-C-2-b	Moist Site	Topsoil	5	5	7	6	3	3	9	9	4	5			5		5		5.6	5.6	5
																					Coverage 16
S1-A-2-c	Flower Haze	Gravel	6	6	6	6	5	5	6	7	4	5			6		7		5.4	5.8	6.5
S1-B-2-c	Prairie	Gravel	6	6	6	6	4	4	5	5	5	6			7		7		5.2	5.4	7
S1-C-2-c	Moist Site	Gravel	1	1	1	1	1	1	1	1	1	1			1		1		1	1	1
S2-A-2-c	Flower Haze	Sandy	7	6	7	6	7	7	7	6	8	8			9		9		7.2	6.6	9
S2-B-2-c	Prairie	Sandy	7	6	7	7	6	6	7	7	9	9			9		9		7.2	7	9
S2-C-2-c	Moist Site	Sandy	5	5	6	6	4	3	5	6	5	4			7		7		5	4.8	7
S3-A-2-c	Flower Haze	Topsoil	7	6	8	7	6	7	6	7	9	9			8		9		7.2	7.2	8.5
S3-B-2-c	Prairie	Topsoil	7	6	6	5	5	4	5	5	7	8			7		7		6	5.6	7
S3-C-2-c	Moist Site	Topsoil	5	5	5	5	4	3	9	9	4	5			4		5		5.4	5.4	4.5

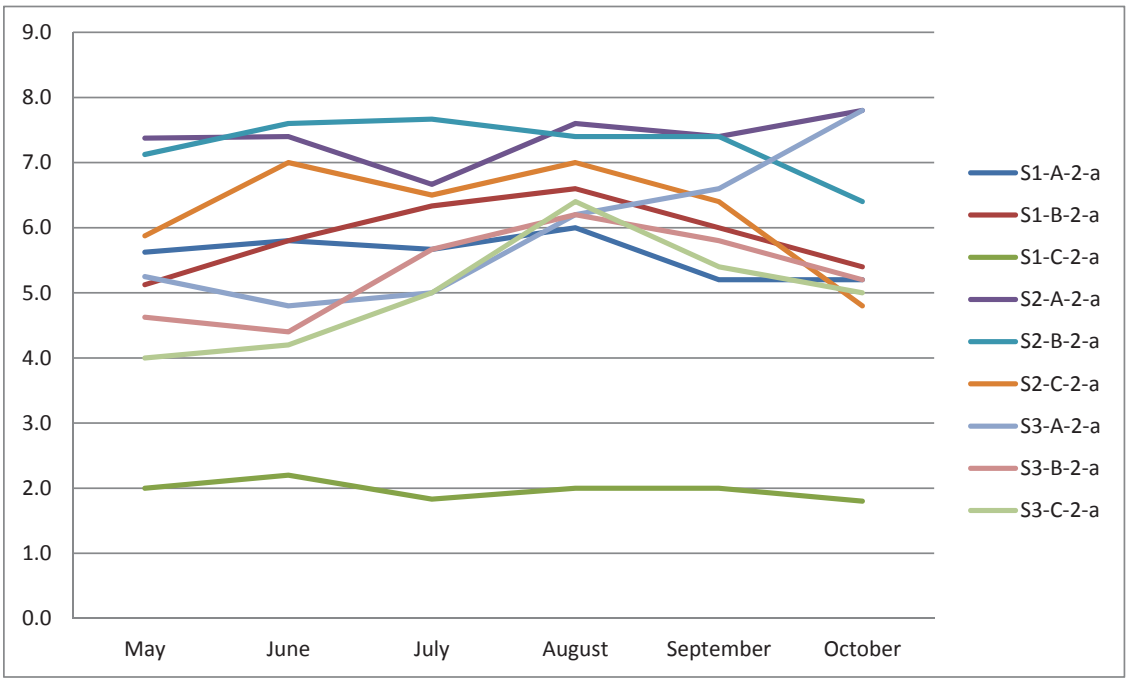
		Number of monitorer:	1		2		3		4		5		6							
Date	September 2016		20/9				20/9		21.09		15.09									
		Monitorer	Ilka Ballerstein		Jessica Fenzl		Thomas Zlobinski		Andy Engelke		Daniela Jürges		Mahziar Gharavi						Average	
Nummer	Mischung	Substrat	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW
S1-A-1-x	Flower Haze	Gravel	5	5	5	5	5	5	5	6	4	3							4.8	4.8
S1-B-1-x	Prairie	Gravel	5	5	5	6	5	4	4	5	3	4							4.4	4.8
S1-C-1-x	Moist Site	Gravel	1	1	1	1	1	1	1	1	1	1							1.0	1.0
S2-A-1-x	Flower Haze	Sandy	6	6	8	7	7	7	9	8	8	5							7.6	6.6
S2-B-1-x	Prairie	Sandy	7	6	8	7	6	6	7	7	8	5							7.2	6.2
S2-C-1-x	Moist Site	Sandy	5	4	6	5	3	3	5	6	6	3							5.0	4.2
S3-A-1-x	Flower Haze	Topsoil	6	6	7	7	6	5	7	8	7	5							6.6	6.2
S3-B-1-x	Prairie	Topsoil	7	7	8	7	5	5	6	5	7	4							6.6	5.6
S3-C-1-x	Moist Site	Topsoil	4	4	6	5	3	4	5	6	5	3							4.6	4.4
S1-A-2-a	Flower Haze	Gravel	6	5	7	6	3	3	5	6	5	4							5.2	4.8
S1-B-2-a	Prairie	Gravel	7	7	8	8	4	4	5	6	6	6							6.0	6.2
S1-C-2-a	Moist Site	Gravel	2	1	4	1	1	1	2	2	1	1							2.0	1.2
S2-A-2-a	Flower Haze	Sandy	7	6	7	7	7	8	8	9	8	9							7.4	7.8
S2-B-2-a	Prairie	Sandy	7	6	8	7	7	7	7	6	8	6							7.4	6.4
S2-C-2-a	Moist Site	Sandy	6	6	6	6	4	5	8	9	8	7							6.4	6.6
S3-A-2-a	Flower Haze	Topsoil	6	6	7	8	6	6	9	8	5	7							6.6	7.0
S3-B-2-a	Prairie	Topsoil	6	6	8	7	4	4	6	8	5	6							5.8	6.2
S3-C-2-a	Moist Site	Topsoil	5	5	7	7	2	2	8	8	5	3							5.4	5.0
S1-A-2-b	Flower Haze	Gravel	6	5	8	7	5	4	6	6	5	5							6.0	5.4
S1-B-2-b	Prairie	Gravel	7	6	8	8	4	3	5	6	5	5							5.8	5.6
S1-C-2-b	Moist Site	Gravel	2	1	3	1	1	1	2	2	1	1							1.8	1.2
S2-A-2-b	Flower Haze	Sandy	7	6	6	5	7	8	7	8	7	5							6.8	6.4
S2-B-2-b	Prairie	Sandy	7	6	9	8	7	8	8	8	8	8							7.8	7.6
S2-C-2-b	Moist Site	Sandy	5	4	6	5	4	3	5	6	4	4							4.8	4.4
S3-A-2-b	Flower Haze	Topsoil	6	6	8	8	6	6	9	9	5	6							6.8	7.0
S3-B-2-b	Prairie	Topsoil	6	6	7	7	5	4	6	7	4	4							5.6	5.6
S3-C-2-b	Moist Site	Topsoil	5	4	6	6	2	2	7	7	4	2							4.8	4.2
S1-A-2-c	Flower Haze	Gravel	5	5	7	6	4	3	5	6	4	5							5.0	5.0
S1-B-2-c	Prairie	Gravel	6	5	7	7	3	3	7	7	5	5							5.6	5.4
S1-C-2-c	Moist Site	Gravel	1	1	1	1	1	1	2	2	1	1							1.2	1.2
S2-A-2-c	Flower Haze	Sandy	7	6	7	6	7	8	8	8	7	6							7.2	6.8
S2-B-2-c	Prairie	Sandy	8	7	9	8	7	7	6	7	8	7							7.6	7.2
S2-C-2-c	Moist Site	Sandy	5	4	7	6	5	4	7	8	5	4							5.8	5.2
S3-A-2-c	Flower Haze	Topsoil	7	6	9	8	6	7	9	9	8	8							7.8	7.6
S3-B-2-c	Prairie	Topsoil	7	7	9	8	6	5	7	8	6	6							7.0	6.8
S3-C-2-c	Moist Site	Topsoil	5	4	6	6	2	2	8	8	4	2							5.0	4.4

		Number of monitorer:	1		2				3		4		5							
Date	October 2016		19/10		18/10				19/10		19/10		19/10							
		Monitorer	Ilka Ballerstein		Jessica Fenzl		Thomas Zlobinski		Andy Engelke		Daniela Jürges		Tim (Praktikant)						Average	
Nummer	Mischung	Substrat	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW
S1-A-1-x	Flower Haze	Gravel	4	3	5	5			3	2	4	3	2	1					3.6	2.8
S1-B-1-x	Prairie	Gravel	4	3	7	6			4	3	5	3	2	1					4.4	3.2
S1-C-1-x	Moist Site	Gravel	1	1	1	1			2	1	1	1	1	1					1.2	1.0
S2-A-1-x	Flower Haze	Sandy	7	7	7	8			7	8	7	8	6	7					6.8	7.6
S2-B-1-x	Prairie	Sandy	8	7	9	8			5	5	9	8	5	3					7.2	6.2
S2-C-1-x	Moist Site	Sandy	5	3	5	4			4	4	4	2	2	1					4.0	2.8
S3-A-1-x	Flower Haze	Topsoil	7	7	7	8			8	8	7	8	7	7					7.2	7.6
S3-B-1-x	Prairie	Topsoil	8	7	9	8			6	5	7	6	3	3					6.6	5.8
S3-C-1-x	Moist Site	Topsoil	5	3	5	5			4	4	5	2	2	1					4.2	3.0
S1-A-2-a	Flower Haze	Gravel	5	4	6	6			5	6	5	3	5	2					5.2	4.2
S1-B-2-a	Prairie	Gravel	6	5	7	6			6	5	6	8	2	2					5.4	5.2
S1-C-2-a	Moist Site	Gravel	2	1	2	2			2	2	2	1	1	1					1.8	1.4
S2-A-2-a	Flower Haze	Sandy	7	7	8	8			8	9	9	9	7	8					7.8	8.2
S2-B-2-a	Prairie	Sandy	7	6	6	6			6	6	9	9	4	5					6.4	6.4
S2-C-2-a	Moist Site	Sandy	6	4	5	6			5	6	7	6	1	2					4.8	4.8
S3-A-2-a	Flower Haze	Topsoil	7	7	8	8			8	9	7	9	9	8					7.8	8.2
S3-B-2-a	Prairie	Topsoil	7	6	7	7			5	4	5	7	2	3					5.2	5.4
S3-C-2-a	Moist Site	Topsoil	6	4	7	5			6	5	4	2	2	1					5.0	3.4
S1-A-2-b	Flower Haze	Gravel	5	5	7	7			6	6	6	5	4	2					5.6	5.0
S1-B-2-b	Prairie	Gravel	6	5	8	7			5	5	5	7	3	2					5.4	5.2
S1-C-2-b	Moist Site	Gravel	2	1	1	1			2	1	1	1	1	1					1.4	1.0
S2-A-2-b	Flower Haze	Sandy	7	6	6	7			8	7	7	7	7	7					7.0	6.8
S2-B-2-b	Prairie	Sandy	7	6	7	7			6	5	7	8	3	3					6.0	5.8
S2-C-2-b	Moist Site	Sandy	5	3	5	5			4	3	4	2	1	1					3.8	2.8
S3-A-2-b	Flower Haze	Topsoil	7	7	8	7			8	9	6	8	9	8					7.6	7.8
S3-B-2-b	Prairie	Topsoil	7	6	8	8			5	4	6	7	5	5					6.2	6.0
S3-C-2-b	Moist Site	Topsoil	6	4	6	5			4	4	3	1	2	2					4.2	3.2
S1-A-2-c	Flower Haze	Gravel	5	4	7	6			3	3	4	5	3	2					4.4	4.0
S1-B-2-c	Prairie	Gravel	5	5	8	7			2	3	4	5	2	1					4.2	4.2
S1-C-2-c	Moist Site	Gravel	1	1	1	1			1	1	1	1	1	1					1.0	1.0
S2-A-2-c	Flower Haze	Sandy	7	6	7	7			8	8	7	8	7	7					7.2	7.2
S2-B-2-c	Prairie	Sandy	7	6	7	8			6	5	9	9	4	5					6.6	6.6
S2-C-2-c	Moist Site	Sandy	5	3	6	6			3	4	5	3	2	2					4.2	3.6
S3-A-2-c	Flower Haze	Topsoil	7	7	8	9			8	9	9	9	9	8					8.2	8.4
S3-B-2-c	Prairie	Topsoil	7	7	7	7			5	5	6	8	4	5					5.8	6.4
S3-C-2-c	Moist Site	Topsoil	5	4	6	5			6	6	3	1	2	2					4.4	3.6

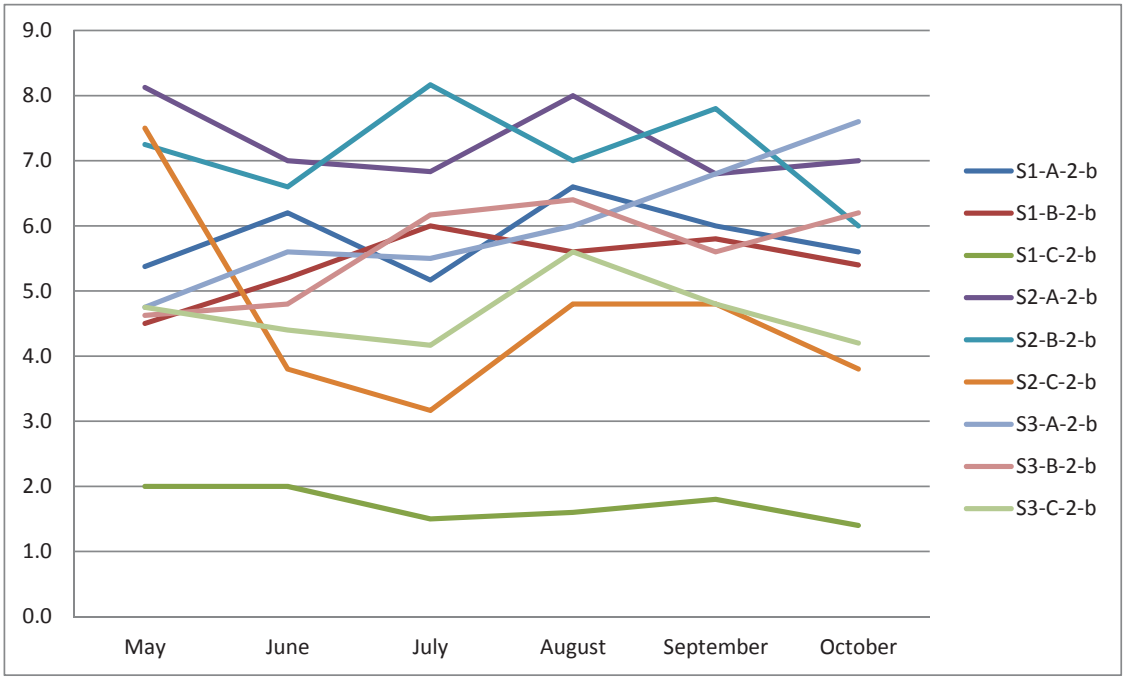
APPENDIX 2

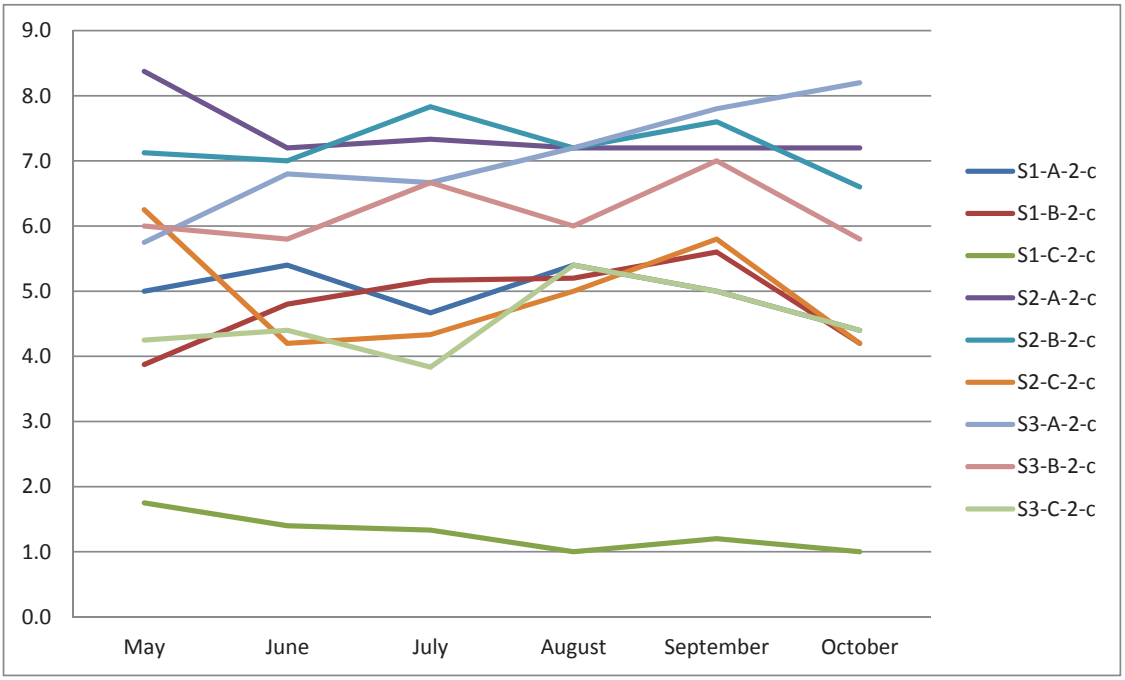
Aesthetic Monitoring 2016 Bernburg





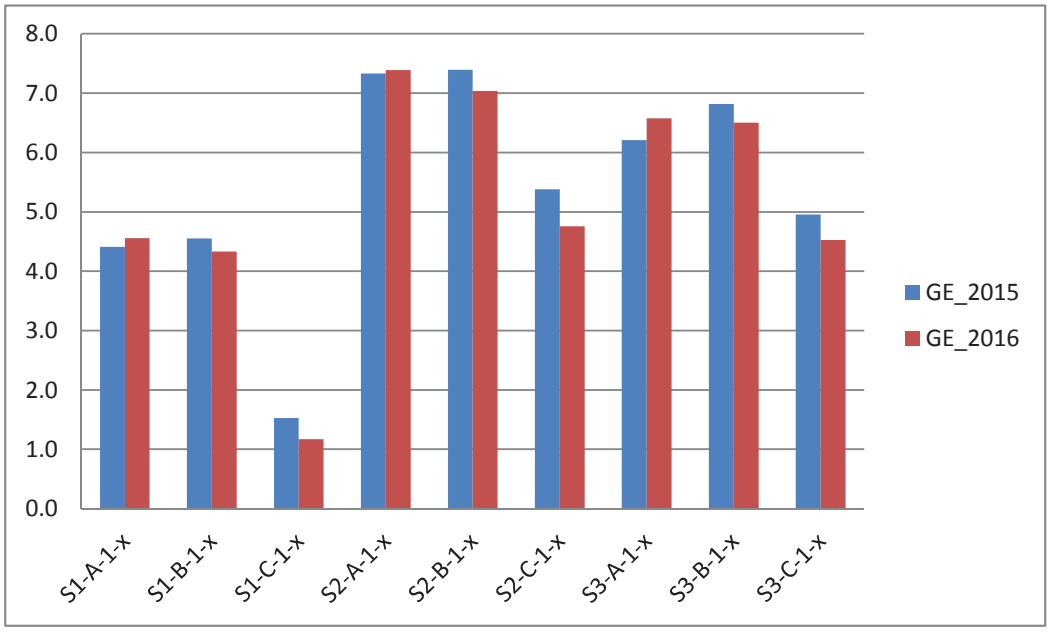
Aesthetic Monitoring 2016 Bernburg

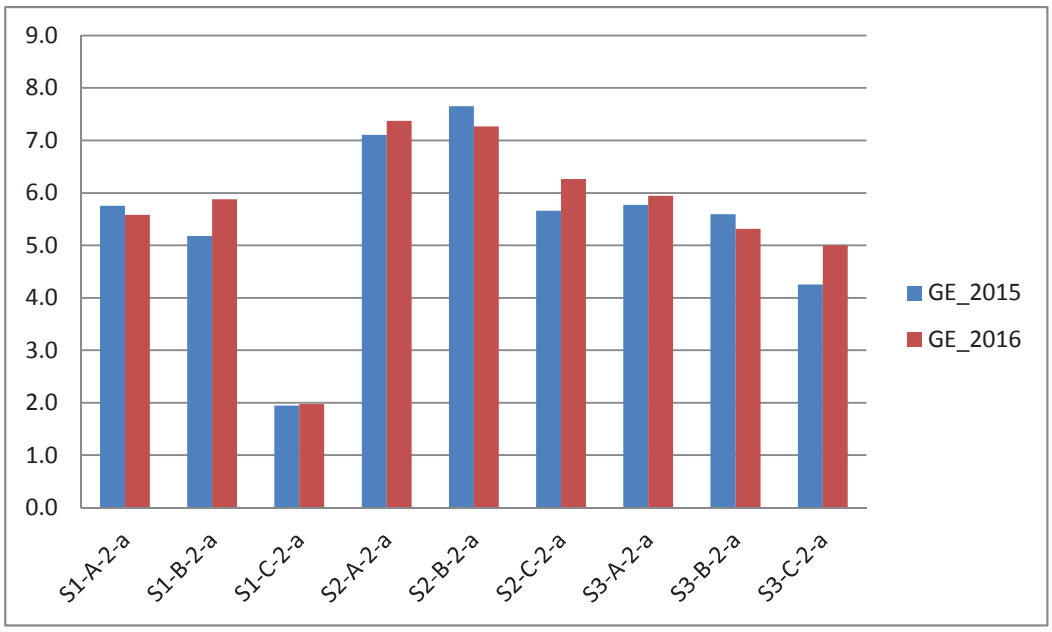




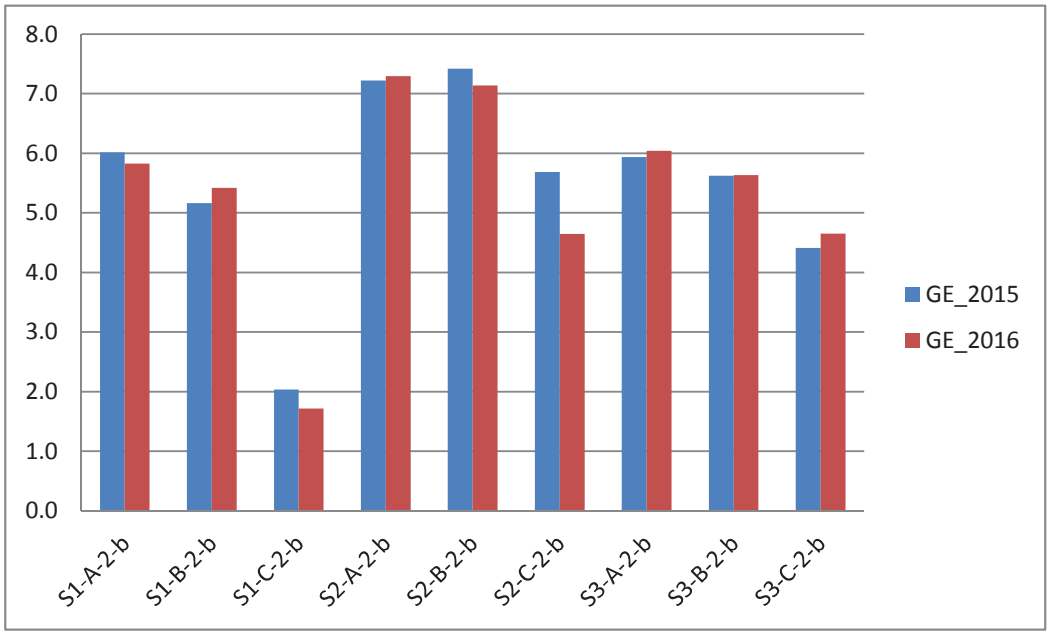
APPENDIX 3

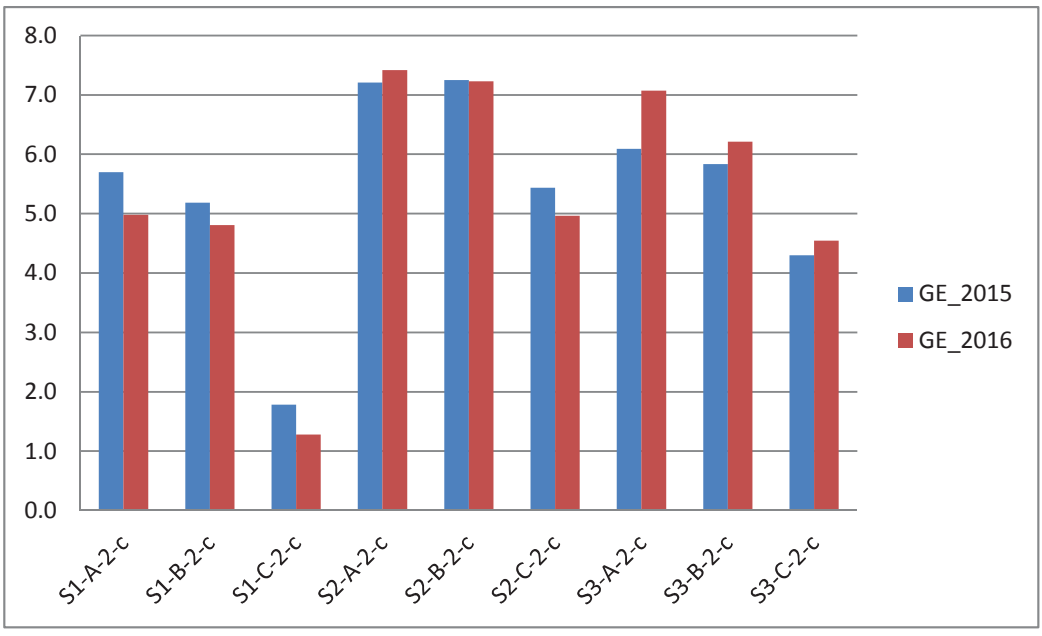
Comparison of the visual results in grading system by evaluators in site between 2015 and 2016





Comparison of the visual results in grading system by evaluators in site between 2015 and 2016





APPENDIX 4

Aesthetic Monitoring 2016 Bernburg

Date			May		June		July		August		September		October			
		Monitorer	Average		Average		Average		Average		Average		Average		Total average	
Number	Mixture	Substrate	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW	GE	SW
S1-A-1-x	Flower Haze	Gravel	4.1	3.4	5	5.2	4.8	4.7	5	5.2	4.8	4.8	3.6	2.8	4.6	4.3
S1-B-1-x	Prairie	Gravel	3.3	2.4	4.6	4.2	5.3	4.5	4	3.8	4.4	4.8	4.4	3.2	4.3	3.8
S1-C-1-x	Moist mixture	Gravel	1.6	1.4	1.2	1	1.0	1.0	1	1	1.0	1.0	1.2	1.0	1.2	1.1
S2-A-1-x	Flower Haze	Sandy	7.8	7.6	8	8.4	7.0	7.2	7.2	7.6	7.6	6.6	6.8	7.6	7.4	7.5
S2-B-1-x	Prairie	Sandy	6.6	5.6	6.8	6	8.0	7.8	6.4	6.6	7.2	6.2	7.2	6.2	7.0	6.4
S2-C-1-x	Moist mixture	Sandy	5.9	5.0	5.6	4.6	3.7	3.0	4.4	4.2	5.0	4.2	4.0	2.8	4.8	4.0
S3-A-1-x	Flower Haze	Topsoil	6.1	5.9	6.4	7	6.3	6.0	6.8	6.2	6.6	6.2	7.2	7.6	6.6	6.5
S3-B-1-x	Prairie	Topsoil	5.3	4.8	6.2	5.2	8.2	7.7	6.2	5.8	6.6	5.6	6.6	5.8	6.5	5.8
S3-C-1-x	Moist mixture	Topsoil	4.9	5.1	5	5	3.7	2.8	4.8	5	4.6	4.4	4.2	3.0	4.5	4.2
															GE	SW
S1-A-2-a	Flower Haze	Gravel	5.6	5.9	5.8	6.8	5.7	5.7	6	6	5.2	4.8	5.2	4.2	5.6	5.6
S1-B-2-a	Prairie	Gravel	5.1	4.5	5.8	5.2	6.3	6.3	6.6	6.8	6.0	6.2	5.4	5.2	5.9	5.7
S1-C-2-a	Moist mixture	Gravel	2.0	2.1	2.2	2.4	1.8	1.5	2	1.6	2.0	1.2	1.8	1.4	2.0	1.7
S2-A-2-a	Flower Haze	Sandy	7.4	7.3	7.4	7.2	6.7	6.2	7.6	7.4	7.4	7.8	7.8	8.2	7.4	7.3
S2-B-2-a	Prairie	Sandy	7.1	6.3	7.6	7.6	7.7	7.5	7.4	7.2	7.4	6.4	6.4	6.4	7.3	6.9
S2-C-2-a	Moist mixture	Sandy	5.9	6.4	7	7	6.5	6.0	7	6.6	6.4	6.6	4.8	4.8	6.3	6.2
S3-A-2-a	Flower Haze	Topsoil	5.3	5.4	4.8	5	5.0	4.0	6.2	6.8	6.6	7.0	7.8	8.2	5.9	6.1
S3-B-2-a	Prairie	Topsoil	4.6	4.0	4.4	4	5.7	5.7	6.2	6.4	5.8	6.2	5.2	5.4	5.3	5.3
S3-C-2-a	Moist mixture	Topsoil	4.0	4.1	4.2	4.6	5.0	4.5	6.4	6	5.4	5.0	5.0	3.4	5.0	4.6
															GE	SW
S1-A-2-b	Flower Haze	Gravel	5.4	5.4	6.2	6.4	5.2	5.3	6.6	6.8	6.0	5.4	5.6	5.0	5.8	5.7
S1-B-2-b	Prairie	Gravel	4.5	3.9	5.2	4.6	6.0	6.0	5.6	6	5.8	5.6	5.4	5.2	5.4	5.2
S1-C-2-b	Moist mixture	Gravel	2.0	1.9	2	2.2	1.5	1.5	1.6	1	1.8	1.2	1.4	1.0	1.7	1.5
S2-A-2-b	Flower Haze	Sandy	8.1	8.0	7	7	6.8	7.2	8	7.6	6.8	6.4	7.0	6.8	7.3	7.2
S2-B-2-b	Prairie	Sandy	7.3	5.9	6.6	5.8	8.2	8.0	7	7	7.8	7.6	6.0	5.8	7.1	6.7
S2-C-2-b	Moist mixture	Sandy	7.5	7.5	3.8	3.6	3.2	2.3	4.8	4.2	4.8	4.4	3.8	2.8	4.6	4.1
S3-A-2-b	Flower Haze	Topsoil	4.8	4.1	5.6	6	5.5	5.0	6	6.6	6.8	7.0	7.6	7.8	6.0	6.1
S3-B-2-b	Prairie	Topsoil	4.6	4.1	4.8	4.6	6.2	5.7	6.4	6.6	5.6	5.6	6.2	6.0	5.6	5.4
S3-C-2-b	Moist mixture	Topsoil	4.8	4.3	4.4	4.8	4.2	3.3	5.6	5.6	4.8	4.2	4.2	3.2	4.7	4.2
															GE	SW
S1-A-2-c	Flower Haze	Gravel	5.0	5.1	5.4	5.6	4.7	4.3	5.4	5.8	5.0	5.0	4.4	4.0	5.0	5.0
S1-B-2-c	Prairie	Gravel	3.9	3.5	4.8	4.6	5.2	5.5	5.2	5.4	5.6	5.4	4.2	4.2	4.8	4.8
S1-C-2-c	Moist mixture	Gravel	1.8	1.5	1.4	1.4	1.3	1.2	1	1	1.2	1.2	1.0	1.0	1.3	1.2
S2-A-2-c	Flower Haze	Sandy	8.4	8.5	7.2	7.2	7.3	7.5	7.2	6.6	7.2	6.8	7.2	7.2	7.4	7.3
S2-B-2-c	Prairie	Sandy	7.1	6.0	7	6.6	7.8	7.8	7.2	7	7.6	7.2	6.6	6.6	7.2	6.9
S2-C-2-c	Moist mixture	Sandy	6.3	5.9	4.2	3.2	4.3	3.3	5	4.8	5.8	5.2	4.2	3.6	5.0	4.3
S3-A-2-c	Flower Haze	Topsoil	5.8	6.3	6.8	7	6.7	6.8	7.2	7.2	7.8	7.6	8.2	8.4	7.1	7.2
S3-B-2-c	Prairie	Topsoil	6.0	4.8	5.8	5.6	6.7	6.8	6	5.6	7.0	6.8	5.8	6.4	6.2	6.0
S3-C-2-c	Moist mixture	Topsoil	4.3	4.4	4.4	4	3.8	3.3	5.4	5.4	5.0	4.4	4.4	3.6	4.5	4.2

APPENDIX 5

Vitality of perennials, 2015 and 2016 in all plots

	Open space - 15 m²		Covered zone - 12 m²					
	Row x		Row a		Row b		Row c	
	Art_S1-A-1x		Art_S1-A-2a		Art_S1-A-2b		Art_S1-A-2c	
Gravel / "Flower Haze"	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16
Aster novae-angliae 'Purple Dom'	0	0	2	2	4	1	1	0
Aster ericoides 'Snowflurry'	2	1	5	2	3	1	3	0
Calamagrostis x acutiflora 'Overdam'	3	2	2	2	4	2	3	0
Achillea clypeolata 'Schwellenburg'	6	6	5	4	6	4	6	4
Gypsophila 'Pink Star'	4	5	5	5	6	7	4	5
Salvia nemorosa 'Mainacht'	4	5	5	5	5	6	5	6
Euphorbia cyparissias 'Fens Ruby'	4	5	5	7	6	5	5	5
Paper atlanticum	5	3	8	5	8	0	9	5
Linaria purpurea	5	5	8	5	7	6	8	1
Anaphalis triplinervis 'Silberregen'	8	4	7	5	7	6	8	7
	Art_S1-B-1x		Art_S1-B-2a		Art_S1-B-2b		Art_S1-B-2c	
Gravel/ "Prairie"	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16
Verbena bonariensis	0	0	0	0	5	0	0	0
Oenothera pilosella	0	0	2	2	3	1	0	0
Agastache foeniculum 'Blue Fortune'	3	1	2	0	3	0	3	5
Aster ericoides 'Pink Spray'	4	0	5	0	4	0	5	2
Penstemon digitalis 'Huskers Red'	2	1	4	4	4	3	3	0
Baptisia australis	3	4	3	2	3	3	0	4
Tradescanthia ohiensis	5	3	5	2	4	1	4	0
Artemisia ludoviciana 'Silver Qeen'	3	4	7	5	3	1	2	3
Liatris spicata 'Floristan Violett'	2	1	4	5	5	3	4	4
Monarda fistulosa var. Menthifolia	3	3	4	5	4	4	4	4
Pycnanthemum tenuifolium	4	2	4	4	4	4	5	4
Echinacea purpurea	4	5	3	4	5	4	6	3
Parthenium integrifolium	7	5	4	5	5	5	4	3
Aster divaricatus 'Tradescant'	4	5	6	7	5	5	5	4
Solidago caesia	5	7	5	7	4	5	5	6
Panicum virgatum 'Hänse Herms'	6	7	5	5	7	5	5	4
Echinacea pallida	6	6	7	7	5	6	6	6
Gaura lindheimeri	7	6	9	7	7	7	8	7

	Art_S1-C-1x		Art_S1-C-2a		Art_S1-C-2b		Art_S1-C-2c	
Gravel / "Moist mixture"	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16
Lobelia siphilitica	0	0	2	0	0	0	0	0
Cardamine pratense	0	0	0	0	2	0	0	0
Filipendula palmata 'Nana'	1	0	3	1	4	1	0	0
Caltha palustris	0	0	3	2	3	2	1	0
Typha minima	0	0	3	2	2	1	3	0
Lychnis flos-cuculi	0	0	3	2	5	0	3	0
Ajuga reptans 'Atropurpurea'	2	0	3	4	4	0	1	0
Filipendula ulmaria 'Plena'	0	0	3	0	4	1	5	1
Lobelia sessilifolia	1	0	4	3	4	1	3	0
Carex flava	2	1	3	2	4	1	3	0
Persicaria officinalis 'Superba'	1	1	3	3	4	2	3	1
Chelone obliqua	1	2	4	3	4	2	3	0
Lythrum salicaria	3	2	4	3	3	4	3	1
Iris sibirica (Wildform)	3	5	4	4	4	4	5	3
Sandy /	**Art_S2-A-1x**		**Art_S2-A-2a**		**Art_S2-A-2b**		**Art_S2-A-2c**	
"Flower Haze"	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16
Achillea clypeolata 'Schwellenburg'	3	5	5	4	5	0	7	4
Aster novae-angliae 'Purple Dom'	6	8	7	9	5	5	9	6
Aster ericoides 'Snowflurry'	8	5	7	7	8	5	8	5
Calamagrostis x acutiflora 'Overdam'	9	7	7	7	9	6	6	6
Euphorbia cyparissias 'Fens Ruby'	8	7	7	8	9	7	12	7
Anaphalis triplinervis 'Silberregen'	8	6	7	6	9	7	7	5
Gypsophila 'Pink Star'	8	8	9	7	9	9	9	9
Linaria purpurea	6	5	9	5	9	7	5	7
Salvia nemorosa 'Mainacht'	9	8	5	5	5	5	6	7
Paper atlanticum	7	6	7	3	5	7	7	7
Sandy /	**Art_S2-B-1x**		**Art_S2-B-2a**		**Art_S2-B-2b**		**Art_S2-B-2c**	
"Prairie"	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16
Agastache foeniculum 'Blue Fortune'	8	5	9	4	7	4	6	7
Artemisia ludoviciana 'Silver Qeen'	9	7	9	5	8	7	9	9
Aster ericoides 'Pink Spray'	9	7	9	9	8	7	8	7
Echinacea purpurea	7	7	8	7	8	7	7	5
Gaura lindheimeri	8	5	9	3	7	7	8	5
Liatris spicata 'Floristan Violett'	4	2	5	7	7	4	7	4
Monarda fistulosa var. Menthifolia	9	7	9	7	8	6	8	5
Oenothera pilosella	2	0	5	7	7	1	4	1
Penstemon digitalis 'Huskers Red'	7	6	7	6	7	5	7	5
Tradescanthia ohiensis	3	3	5	3	5	1	4	3
Echinacea pallida	7	7	8	5	8	8	8	5
Parthenium integrifolium	6	7	5	6	7	4	5	5
Pycnanthemum tenuifolium	8	5	7	6	6	5	6	4
Solidago caesia	5	6	8	8	7	5	8	7
Aster divaricatus 'Tradescant'	9	9	8	7	8	8	8	9
Verbena bonariensis	9	5	9	6	9	7	8	7
Panicum virgatum 'Hänse Herms'	9	7	8	5	8	7	5	4
Baptisia australis	7	9	0	0	0	0	4	5

Sandy / "Moist mixture"	Art_S2-C-1x		Art_S2-C-2a		Art_S2-C-2b		Art_S2-C-2c	
	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16
Ajuga reptans 'Atropurpurea'	5	3	9	3	5	3	4	4
Filipendula palmata 'Nana'	6	5	8	3	6	2	4	3
Caltha palustris	0	0	8	8	5	2	5	3
Iris sibirica (Wildform)	9	7	9	8	7	6	7	7
Lobelia siphilitica	6	3	7	5	6	4	5	5
Lythrum salicaria	5	3	9	8	7	4	4	3
Persicaria officinalis 'Superba'	8	3	8	6	8	3	5	4
Typha minima	4	1	7	7	6	2	3	1
Lobelia sessilifolia	3	0	8	7	6	3	4	0
Lychnis flos-cuculi	5	4	8	7	9	7	6	5
Chelone obliqua	6	7	7	7	6	5	6	6
Carex flava	8	7	9	7	9	5	6	7
Cardamine pratense	2	0	5	0	3	0	7	3
Filipendula ulmaria 'Plena'	7	5	7	0	7	4	6	4
Topsoil / "Flower Haze"	**Art_S3-A-1x**		**Art_S3-A-2a**		**Art_S3-A-2b**		**Art_S3-A-2c**	
	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16
Achillea clypeolata 'Schwellenburg'	5	5	6	4	4	4	5	7
Aster novae-angliae 'Purple Dom'	9	7	7	8	6	5	6	7
Aster ericoides 'Snowflurry'	8	5	6	6	5	5	8	8
Calamagrostis x acutiflora 'Overdam'	7	4	7	6	6	6	5	5
Euphorbia cyparissias 'Fens Ruby'	5	5	3	3	3	3	5	6
Anaphalis triplinervis 'Silberregen'	6	3	7	6	4	4	5	7
Gypsophila 'Pink Star'	5	5	4	3	5	4	7	7
Linaria purpurea	0	3	5	2	3	0	4	2
Salvia nemorosa 'Mainacht'	6	6	5	4	3	4	4	7
Paper atlanticum	6	5	6	4	2	0	0	0

Topsoil / "Prairie"	Art_S3-B-1x		Art_S3-B-2a		Art_S3-B-2b		Art_S3-B-2c	
	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16
Agastache foeniculum 'Blue Fortune'	7	7	0	0	2	0	1	0
Artemisia ludoviciana 'Silver Qeen'	9	4	6	2	6	3	9	5
Aster ericoides 'Pink Spray'	8	7	5	4	5	5	5	4
Echinacea purpurea	8	7	5	5	5	5	6	4
Gaura lindheimeri	8	7	8	5	5	5	7	8
Liatris spicata 'Floristan Violett'	4	7	5	5	4	4	4	3
Monarda fistulosa var. Menthifolia	7	5	5	4	5	2	6	4
Oenothera pilosella	2	1	3	3	5	1	3	1
Penstemon digitalis 'Huskers Red'	5	5	4	3	4	2	4	3
Tradescanthia ohiensis	6	0	2	0	3	0	3	0
Echinacea pallida	8	8	5	5	5	5	5	6
Parthenium integrifolium	6	6	4	3	4	4	3	2
Pycnanthemum tenuifolium	6	4	5	3	4	3	3	3
Solidago caesia	6	8	5	6	5	5	4	6
Aster divaricatus 'Tradescant'	8	6	5	5	5	5	5	5
Verbena bonariensis	8	5	8	0	5	0	8	4
Panicum virgatum 'Hänse Herms'	7	5	5	4	4	4	4	4
Baptisia australis		4	0	0	0	0	5	7
Topsoil / "Moist mixture"	**Art_S3-C-1x**		**Art_S3-C-2a**		**Art_S3-C-2b**		**Art_S3-C-2c**	
	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16	Vitality 15	Vitality 16
Ajuga reptans 'Atropurpurea'	4	4	3	3	4	2	3	1
Filipendula palmata 'Nana'	7	4	5	4	6	2	5	2
Caltha palustris	4	0	3	0	4	1	2	0
Iris sibirica (Wildform)	8	6	6	5	7	5	4	5
Lobelia siphilitica	5	4	4	5	5	4	4	4
Lythrum salicaria	5	4	4	4	5	4	3	3
Persicaria officinalis 'Superba'	7	4	4	3	4	2	2	1
Typha minima	0	4	6	7	7	7	4	5
Lobelia sessilifolia	3	3	5	4	5	4	4	4
Lychnis flos-cuculi	5	3	5	4	5	2	4	0
Chelone obliqua	6	5	4	3	5	4	4	3
Carex flava	7	5	6	4	6	3	5	3
Cardamine pratense	0	0	2	2	3	0	0	0
Filipendula ulmaria 'Plena'	7	5	7	5	7	4	4	4

APPENDIX 6

Coexistence 2015 and 2016

	Open space - 15 m²		Covered zone - 12 m²					
	Row x		Row a		Row b		Row c	
	Art_S1-A-1x		Art_S1-A-2a		Art_S1-A-2b		Art_S1-A-2c	
Gravel / "Flower Haze"	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16
Achillea clypeolata 'Schwellenburg'	0	-1	-1	0	-2	-1	-2	-1
Aster novae-angliae 'Purple Dom'	0	-	-1	0	-1	0	0	-
Aster ericoides 'Snowflurry'	0	0	-1	-1	-1	0	-1	-
Calamagrostis x acutiflora 'Overdam'	0	0	-1	-1	-2	-1	-3	-
Euphorbia cyparissias 'Fens Ruby'	0	2	1	-4	1	1	0	-1
Anaphalis triplinervis 'Silberregen'	0	-1	1	0	1	-1	1	-1
Gypsophila 'Pink Star'	0	-1	1	1	3	5	0	2
Linaria purpurea	0	0	1	0	1	0	1	0
Salvia nemorosa 'Mainacht'	8	0	1	-1	-1	-1	-1	-2
Paper atlanticum	0	-1	1	0	1	-	1	-1
	Art_S1-B-1x		Art_S1-B-2a		Art_S1-B-2b		Art_S1-B-2c	
Gravel / "Prairie"	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16
Agastache foeniculum 'Blue Fortune'	0	0	-2	-	-1	-	-2	-1
Artemisia ludoviciana 'Silver Qeen'	0	0	2	1	-1	-1	-1	0
Aster ericoides 'Pink Spray'	0	-	-1	-	0	-	0	-5
Echinacea purpurea	0	0	0	0	0	0	-1	0
Gaura lindheimeri	2	0	6	1	5	1	3	3
Liatris spicata 'Floristan Violett'	0	0	-1	0	0	0	-1	0
Monarda fistulosa var. Menthifolia	0	0	0	0	0	-1	-1	0
Oenothera pilosella		-	0	0	0	0		-
Penstemon digitalis 'Huskers Red'	0	0	-1	0	-1	0	-1	-
Tradescanthia ohiensis	0	0	-1	0	0	0	-1	-
Echinacea pallida	0	0	0	0	0	0	-1	0
Parthenium integrifolium	-1	0	-2	-1	-1	-1	-1	0
Pycnanthemum tenuifolium	0	0	-1	-1	-1	0	-1	0
Solidago caesia	0	0	-1	0	-1	0	0	0
Aster divaricatus 'Tradescant'	0	0	1	1	1	-1	-1	0
Verbena bonariensis		-		-	-1	-		-
Panicum virgatum 'Hänse Herms'	0	0	-1	-1	0	0	-1	0
Baptisia australis	0	0	5	-3	1	-1		-3

	Art_S1-C-1x		Art_S1-C-2a		Art_S1-C-2b		Art_S1-C-2c	
Gravel / "Moist mixture"	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16
Ajuga reptans 'Atropurpurea'	0	-	0	0	0	-	0	-
Filipendula palmata 'Nana'	0	-	0	0	0	0	5	-
Caltha palustris		-	0	0	0	0	0	-
Iris sibirica (Wildform)	0	0	0	0	0	0	0	0
Lobelia siphilitica		-	0	-		-	0	-
Lythrum salicaria	0	0	0	0	0	0	0	0
Persicaria officinalis 'Superba'	0	0	0	0	0	0	0	0
Typha minima		-	0	0	0	0	0	-
Lobelia sessilifolia		-	0	0	0	0	0	-
Lychnis flos-cuculi		-	0	0	0	-	0	-
Chelone obliqua	0	0	0	0	0	0	0	-
Carex flava	0	0	0	0	0	0	0	-
Cardamine pratense		-			0	-	0	-
Filipendula ulmaria 'Plena'		-	0		0	0	0	0
Sandy / "Flower Haze"	**Art_S2-A-1x**		**Art_S2-A-2a**		**Art_S2-A-2b**		**Art_S2-A-2c**	
	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16
Achillea clypeolata 'Schwellenburg'	-1	-1	-3	-4	-7	-	-1	-2
Aster novae-angliae 'Purple Dom'	-1	-2	2	0	-3	-7	1	-4
Aster ericoides 'Snowflurry'	-1	-4	-2	-4	-3	-5	1	-7
Calamagrostis x acutiflora 'Overdam'	-1	0	-1	0	-1	0	0	-1
Euphorbia cyparissias 'Fens Ruby'	3	3	-1	0	-4	0	-1	-1
Anaphalis triplinervis 'Silberregen'	-2	-4	2	1	-2	-3	0	-1
Gypsophila 'Pink Star'	3	-1	5	1	7	7	2	7
Linaria purpurea	-3	-1	1	0	-2	0	0	-3
Salvia nemorosa 'Mainacht'	3	1	-2	-1	-2	-3	-2	-4
Paper atlanticum	-5	-1	-2	0	-5	-1	0	-3
Sandy / "Prairie"	**Art_S2-B-1x**		**Art_S2-B-2a**		**Art_S2-B-2b**		**Art_S2-B-2c**	
	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16
Agastache foeniculum 'Blue Fortune'	1	0	-1	-2	-2	-5	-1	-1
Artemisia ludoviciana 'Silver Qeen'	7	5	7	0	6	3	7	5
Aster ericoides 'Pink Spray'	0	-1	1	0	0	0	-1	-1
Echinacea purpurea	-3	0	-1	0	-1	0	-1	-1
Gaura lindheimeri	3	1	5	-5	-1	0	5	0
Liatris spicata 'Floristan Violett'	-3	-1	-1	-1	-2	-1	-2	-1
Monarda fistulosa var. Menthifolia	1	0	0	0	1	0	-1	-1
Oenothera pilosella	-1	-	-1	0	0	0	-1	0
Penstemon digitalis 'Huskers Red'	-2	-1	-1	0	-2	-1	-1	-2
Tradescanthia ohiensis	-1	-1	-1	0	-2	0	-1	0
Echinacea pallida	-2	0	-2	0	-1	0	-1	0
Parthenium integrifolium	-1	-1	-5	-1	-3	4-6	-2	-3
Pycnanthemum tenuifolium	-1	-1	-3	-1	-2	-1	-2	-1
Solidago caesia	-2	1	-1	0	0	0	-1	0
Aster divaricatus 'Tradescant'	2	1	-1	3	2	-1	1	4
Verbena bonariensis	-1	0	-1	0	-2	0	-1	0
Panicum virgatum 'Hänse Herms'	0	1	-1	-1	-1	-1	-2	-5
Baptisia australis	0	1					-3	-1

Sandy / "Moist mixture"	Art_S2-C-1x		Art_S2-C-2a		Art_S2-C-2b		Art_S2-C-2c	
	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16
Ajuga reptans 'Atropurpurea'	0	0	-1	0	0	0	0	0
Filipendula palmata 'Nana'	0	0	-1	-1	-1	-1	0	0
Caltha palustris		-	0	0	-1	0	0	0
Iris sibirica (Wildform)	0	0	0	0	-1	0	0	0
Lobelia siphilitica	0	0	0	0	0	-1	0	0
Lythrum salicaria	-1	0	0	0	0	0	0	0
Persicaria officinalis 'Superba'	3	0	0	0	1	0	1	0
Typha minima	0	0	1	1	-1	-1	0	0
Lobelia sessilifolia	0	-	0	0	0	0	0	-
Lychnis flos-cuculi	0	0	0	-1	0	1	0	0
Chelone obliqua	0	0	0	0	0	0	0	0
Carex flava	1	0	1	1	1	0	-1	0
Cardamine pratense	0	-	0	-	0	-	0	0
Filipendula ulmaria 'Plena'	2	0	-1	-	2	0	1	0
Topsoil / "Flower Haze"	**Art_S3-A-1x**		**Art_S3-A-2a**		**Art_S3-A-2b**		**Art_S3-A-2c**	
	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16
Achillea clypeolata 'Schwellenburg'	-1	0	0	-1	-1	-1	-1	-2
Aster novae-angliae 'Purple Dom'	2	0	1	0	1	0	1	-1
Aster ericoides 'Snowflurry'	2	0	1	0	1	1	1	-3
Calamagrostis x acutiflora 'Overdam'	-1	0	0	0	0	0	0	0
Euphorbia cyparissias 'Fens Ruby'	-1	0	0	0	0	0	-1	-2
Anaphalis triplinervis 'Silberregen'	-1	-1	1	0	0	-1	0	-1
Gypsophila 'Pink Star'	1	1	0	0	2	1	2	5
Linaria purpurea	0	0	0	0	0	-	0	-5
Salvia nemorosa 'Mainacht'	-1	0	0	0	0	0	-2	-3
Papaver atlanticum	-1	0	0	0	0	-	0	-

Topsoil / "Prairie"	Art_S3-B-1x		Art_S3-B-2a		Art_S3-B-2b		Art_S3-B-2c	
	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16
Agastache foeniculum 'Blue Fortune'	0	0		-	0	-	0	-
Artemisia ludoviciana 'Silver Qeen'	7	0	2	0	3	0	7	3
Aster ericoides 'Pink Spray'	0	0	0	0	0	0	0	-1
Echinacea purpurea	0	0	0	0	0	0	-1	-1
Gaura lindheimeri	2	-1	5	1	1	0	3	5
Liatris spicata 'Floristan Violett'	-2	0	0	0	0	0	0	0
Monarda fistulosa var. Menthifolia	1	-2	0	0	0	0	-1	-5
Oenothera pilosella	0	0	0	0	0	0	-1	0
Penstemon digitalis 'Huskers Red'	0	0	0	0	0	0	0	-1
Tradescanthia ohiensis	0	-	0	-	0	-	0	-
Echinacea pallida	-1	0	0	0	0	0	0	-1
Parthenium integrifolium	-1	0	0	-1	0	-1	-1	-1
Pycnanthemum tenuifolium	1	-1	0	0	-1	0	-2	-1
Solidago caesia	-2	1	0	0	0	0	-1	-2
Aster divaricatus 'Tradescant'	1	1	0	1	1	0	-1	-3
Verbena bonariensis	0	0	0	-	0	-	-1	-1
Panicum virgatum 'Hänse Herms'	-1	-0.5	-1	-1	0	0	-2	-2
Baptisia australis		-1					1	1
Topsoil / "Moist mixture"	**Art_S3-C-1x**		**Art_S3-C-2a**		**Art_S3-C-2b**		**Art_S3-C-2c**	
	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16	Coexistence 15	Coexistence 16
Ajuga reptans 'Atropurpurea'	0	0	0	0	0	0	0	0
Filipendula palmata 'Nana'	0	0	0	0	0	0	0	0
Caltha palustris	0	-	0	-	0	0	0	-
Iris sibirica (Wildform)	0	0	0	0	0	0	0	0
Lobelia siphilitica	0	0	0	0	0	0	0	0
Lythrum salicaria	0	0	0	0	0	0	0	0
Persicaria officinalis 'Superba'	2	0	0	0	0	0	0	0
Typha minima		0	0	0	0	0	0	0
Lobelia sessilifolia	0	0	0	0	0	0	0	0
Lychnis flos-cuculi	0	0	0	0	0	0	0	-
Chelone obliqua	0	0	0	0	0	0	0	0
Carex flava	1	0	0	0	-1	0	0	0
Cardamine pratense		-	0	0	0	-	0	-
Filipendula ulmaria 'Plena'	1	0	0	0	1	0	0	0

APPENDIX 7

Individual monitoring 2016

Open space - 15 m²

Art_S1-A-1x	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	14	6	-1	25
Aster 'Purple Dom'	0	-	-	-
Aster 'Snow Flurry'	7	1	0	5
Calamagrostis 'Overdam'	5	2	0	60
Euphorbia	13	5	2	30
Anaphalis triplinervis	7	4	-1	30
Gypsophila 'Pink Star'	5	5	-1	30
Linaria purpurea	2	5	0	50
Salvia 'Mainacht'	14	5	0	20
Paper atlanticum	5	3	-1	10
Art_S1-B-1x	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	2	1	0	20
Artemisia 'Silver Queen'	2	4	0	50
Aster 'Pink Spray'	0	-	-	-
Echinacea purpurea	7	5	0	35
Gaura lindheimeri	1	6	0	90
Liastris spicata	1	1	0	5
Monarda- Hybride	3	3	0	40
Oenothra	0	-	-	-
Penstemon 'Huskers Red'	1	1	0	5
Tradescanthia ohiensis	7	3	0	10
Echinacea pallida	6	6	0	60
Parthenium integrifolium	2	5	0	30/110
Pycnanthemum tenuifolium	13	2	0	25
Solidago caesia	2	7	0	90
Aster divaricatus 'Tradescant'	15	5	0	40
Verbena bonariensis	0	-	-	-
Panicum virgatum	3	7	0	80
Baptisia australis	2	4	0	65
Art_S1-C-1x	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	0	-	-	-
Filipendula palmata 'Nana'	0	-	-	-
Caltha palustris	0	-	-	-
Iris sibirica (Wildform)	5	5	0	30
Lobelia siphilitica	0	-	-	-
Lythrum salicaria	6	2	0	15
Persicaria officinalis	2	1	0	5
Typha minima	0	-	-	-
Lobelia sessilifolia	0	-	-	-
Lychnis flos-cuculi	0	-	-	-
Chelone obliqua	1	2	0	20
Carex flava	1	1	0	5
Cardamine pratense	0	-	-	-
Filipendula ulmaria	0	-	-	-

Covered zone – Row c

Art_S1-A-2c	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	8	3-4	-1	30
Aster 'Purple Dom'	0	-	-	-
Aster 'Snow Flurry'	0	-	-	-
Calamagrostis 'Overdam'	0	-	-	-
Euphorbia	11	5	-1	15
Anaphalis triplinervis	6	7	-1	40
Gypsophila 'Pink Star'	4	5	2	40
Linaria purpurea	3	1	0	70
Salvia 'Mainacht'	3	6	-2	40
Paper atlanticum	6	5	-1	30
Art_S1-B-2c	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	1	5	-1	90
Artemisia 'Silver Queen'	1	3-4	0	50
Aster 'Pink Spray'	1	2	-5	30
Echinacea purpurea	6	3	0	40
Gaura lindheimeri	2	7	3	100
Liastris spicata	3	3-4	0	10
Monarda- Hybride	2	3-4	0	40
Oenothra	0	-	-	-
Penstemon 'Huskers Red'	0	-	-	-
Tradescanthia ohiensis	0	-	-	-
Echinacea pallida	4	6	0	100
Parthenium integrifolium	2	3	0	30
Pycnanthemum tenuifolium	6	4	0	40
Solidago caesia	2	6	0	80
Aster divaricatus 'Tradescant'	9	4	0	50
Verbena bonariensis	0	-	-	-
Panicum virgatum	2	3-4	0	80
Babtisia australis	1	4	-3	60
Art_S1-C-2c	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	0	-	-	-
Filipendula palmata 'Nana'	0	-	-	-
Caltha palustris	0	-	-	-
Iris sibirica (Wildform)	3	3	0	50
Lobelia siphilitica	0	-	-	-
Lythrum salicaria	2	1	0	5
Persicaria officinalis	4	1	0	5
Typha minima	0	-	-	-
Lobelia sessilifolia	0	-	-	-
Lychnis flos-cuculi	0	-	-	-
Chelone obliqua	0	-	-	-
Carex flava	0	-	-	-
Cardamine pratense	0	-	-	-
Filipendula ulmaria	3	1	0	5

Art_S2-A-2c	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	1	4	-2	25
Aster 'Purple Dom'	11	6	-4	60
Aster 'Snow Flurry'	5	5	-7	10
Calamagrostis 'Overdam'	6	6	-1	120
Euphorbia	12	7	-1	30
Anaphalis triplinervis	4	5	-1	30
Gypsophila 'Pink Star'	9	9	7	30
Linaria purpurea	8	7	-3	90
Salvia 'Mainacht'	10	7	-4	45
Paper atlanticum	4	7	-3	50
Art_S2-B-2c	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	2	7	-1	110
Artemisia 'Silver Queen'	2	9	5	55
Aster 'Pink Star'	2	7	-1	75
Echinacea purpurea	8	5	-1	75
Gaura lindheimeri	2	5	0	110
Liatris spicata	4	3-4	-1	20
Monarda- Hybride	5	5	-1	100
Oenothra	1	1	0	10
Penstemon 'Huskers Red'	5	5	-2	60
Tradescanthia ohiensis	3	3	0	5
Echinacea pallida	5	5	0	90
Parthenium integrifolium	2	5	-3	100
Pycnanthemum tenuifolium	7	4	-1	50
Solidago caesia	2	7	0	90
Aster divaricatus 'Tradescant'	10	9	4	60
Verbena bonariensis	3	7	0	130
Panicum virgatum	2	4	-5	100
Babtisia australis	1	5	-1	70
Art_S2-C-2c	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	3	4	0	5
Filipendula palmata 'Nana'	8	3	0	10
Caltha palustris	1	3	0	5
Iris sibirica (Wildform)	4	7	0	90
Lobelia siphilitica	12	5	0	50
Lythrum salicaria	5	3	0	60
Persicaria officinalis	4	4	0	10
Typha minima	6	1	0	10
Lobelia sessilifolia	0	-	-	-
Lychnis flos-cuculi	16	5	0	5
Chelone obliqua	4	6	0	70
Carex flava	18	7	0	15
Cardamine pratense	2	3	0	5
Filipendula ulmaria	4	4	0	30

Art_S3-A-2c	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	7	7	-2	40
Aster 'Purple Dom'	11	7	-1	50
Aster 'Snow Flurry'	7	8	-3	25
Calamagrostis 'Overdam'	5	5	0	110
Euphorbia	7	6	-2	30
Anaphalis triplinervis	8	7	-1	40
Gypsophila 'Pink Star'	6	7	5	50
Linaria purpurea	1	2	-5	40
Salvia 'Mainacht'	4	7	-3	40
Paper atlanticum	0	-	-	-
Art_S3-B-2c	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	0	-	-	-
Artemisia 'Silver Queen'	2	5	3	85
Aster 'Pink Star'	4	4	-1	100
Echinacea purpurea	5	4	-1	70
Gaura lindheimeri	2	8	5	100
Liastris spicata	4	3	0	25
Monarda- Hybride	5	4	-5	90
Oenothra	2	1	0	5
Penstemon 'Huskers Red'	4	3	-1	45
Tradescanthia ohiensis	0	-	-	-
Echinacea pallida	6	6	-1	90
Parthenium integrifolium	2	2	-1	25
Pycnanthemum tenuifolium	7	3-4	-1	60
Solidago caesia	2	6	-2	100
Aster divaricatus 'Tradescant'	11	5	-3	70
Verbena bonariensis	2	3-4	-1	110
Panicum virgatum	2	4	-2	120
Babtisia australis	1	7	1	110
Art_S3-C-2c	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	7	1	0	5
Filipendula palmata 'Nana'	5	2	0	10
Caltha palustris	0	-	-	-
Iris sibirica (Wildform)	4	5	0	110
Lobelia siphilitica	30	4	0	30
Lythrum salicaria	5	3	0	40
Persicaria officinalis	3	1	0	5
Typha minima	10	5	0	50
Lobelia sessilifolia	2	4	0	50
Lychnis flos-cuculi	0	-	-	-
Chelone obliqua	3	3	0	45
Carex flava	10	3	0	10
Cardamine pratense	0	-	-	-
Filipendula ulmaria	3	4	0	25

Art_S2-A-1x	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	3	5	-1	30
Aster 'Purple Dom'	12	8	-2	45
Aster 'Snow Flurry'	8	5	-4	15
Calamagrostis 'Overdam'	7	7	0	130
Euphorbia	25% Coverage	7	3	35
Anaphalis triplinervis	7	6	-4	45
Gypsophila 'Pink Star'	9	8	-1	50
Linaria purpurea	5	5	-1	55
Salvia 'Mainacht'	11	8	1	55
Paper atlanticum	6	6	-1	50
Art_S2-B-1x	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	2	5	0	50/110
Artemisia 'Silver Queen'	2	7	5	40
Aster 'Pink Star'	2	7	-1	90
Echinacea purpurea	6	7	0	85
Gaura lindheimeri	2	5	1	90
Liastris spicata	4	2	-1	10
Monarda- Hybride	5	7	0	100
Oenothra	0	-	-	-
Penstemon 'Huskers Red'	4	6	-1	70
Tradescanthia ohiensis	1	3	-1	40
Echinacea pallida	5	7	0	80
Parthenium integrifolium	1	7	-1	100
Pycnanthemum tenuifolium	8	5	-1	55
Solidago caesia	2	6	1	90
Aster divaricatus 'Tradescant'	15	9	1	80
Verbena bonariensis	4	5	0	100
Panicum virgatum	3	7	1	110
Baptisia australis	1	9	1	95
Art_S2-C-1x	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	4	3	0	5
Filipendula palmata 'Nana'	14	5	0	10
Caltha palustris	0	-	-	-
Iris sibirica (Wildform)	5	7	0	90
Lobelia siphilitica	14	3	0	20
Lythrum salicaria	4	3	0	55
Persicaria officinalis	5	3	0	15
Typha minima	Remained	1	0	20
Lobelia sessilifolia	0	-	-	-
Lychnis flos-cuculi	Isolated	4	0	5
Chelone obliqua	6	7	0	80
Carex flava	15	7	0	30
Cardamine pratense	0	-	-	-
Filipendula ulmaria	3	5	0	15

Art_S3-A-1x	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	7	5	0	20
Aster 'Purple Dom'	15	7	0	40
Aster 'Snow Flurry'	9	5	0	15
Calamagrostis 'Overdam'	6	4	0	120
Euphorbia	7	5	0	25
Anaphalis triplinervis	8	3	-1	30
Gypsophila 'Pink Star'	7	5	1	55
Linaria purpurea	5	3	0	80
Salvia 'Mainacht'	10	6	0	40
Paper atlanticum	10	5	0	35
Art_S3-B-1x	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	1	7	0	90
Artemisia 'Silver Queen'	3	4	0	80
Aster 'Pink Star'	2	7	0	100
Echinacea purpurea	12	7	0	100
Gaura lindheimeri	2	7	-1	100
Liatris spicata	2	7	0	75
Monarda- Hybride	6	5	-2	90
Oenothra	3	1	0	10
Penstemon 'Huskers Red'	4	5	0	70
Tradescanthia ohiensis	0	-	-	-
Echinacea pallida	6	8	0	80
Parthenium integrifolium	1	6	0	90
Pycnanthemum tenuifolium	12	4	-1	65
Solidago caesia	2	8	1	100
Aster divaricatus 'Tradescant'	13	6	1	80
Verbena bonariensis	2	5	0	65
Panicum virgatum	3	5	-0.5	100
Baptisia australis	2	4	-1	70
Art_S3-C-1x	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	1	4	0	5
Filipendula palmata 'Nana'	12	3-4	0	5
Caltha palustris	0	-	-	-
Iris sibirica (Wildform)	5	6	0	75
Lobelia siphilitica	6	4	0	35
Lythrum salicaria	5	4	0	45
Persicaria officinalis	8	4	0	10
Typha minima	Isolated	3-4	0	20
Lobelia sessilifolia	3	3	0	45
Lychnis flos-cuculi	3	3	0	5
Chelone obliqua	4	5	0	80
Carex flava	18	5	0	20
Cardamine pratense	0	-	-	-
Filipendula ulmaria	5	5	0	10

Covered zone – Row a

Art_S1-A-2a	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	4	4	0	20
Aster 'Purple Dom'	7	2	0	25
Aster 'Snow Flurry'	5	2	-1	50
Calamagrostis 'Overdam'	6	2	-1	70
Euphorbia	40.00%	7	-4	40
Anaphalis triplinervis	7	5	0	35
Gypsophila 'Pink Star'	6	5	1	50
Linaria purpurea	6	5	0	55
Salvia 'Mainacht'	6	5	-1	20
Paper atlanticum	2	5	0	25
Art_S1-B-2a	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	0	-	-	-
Artemisia 'Silver Queen'	2	5	1	40
Aster 'Pink Spray'	0	-	-	-
Echinacea purpurea	9	4	0	60
Gaura lindheimeri	2	7	1	100
Liastris spicata	5	5	0	30
Monarda- Hybride	3	5	0	100
Oenothra	1	2	0	10
Penstemon 'Huskers Red'	2	3-4	0	40
Tradescanthia ohiensis	5	2	0	5
Echinacea pallida	5	7	0	110
Parthenium integrifolium	2	5	-1	70
Pycnanthemum tenuifolium	7	4	-1	60
Solidago caesia	2	7	0	110
Aster divaricatus 'Tradescant'	11	7	1	65
Verbena bonariensis	0	-	-	-
Panicum virgatum	2	5	-1	100
Baptisia australis	15-20%	2	-3	60
Art_S1-C-2a	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	1	4	0	5
Filipendula	12	1	0	5
Caltha palustris	4	2	0	5
Iris sibirica (Wildform)	4	4	0	5
Lobelia siphilitica	0	-	-	-
Lythrum salicaria	5	3	0	50
Persicaria officinalis	4	3	0	10
Typha minima	4	2	0	20
Lobelia sessilifolia	3	3	0	40
Lychnis flos-cuculi	3	2	0	5
Chelone obliqua	4	3	0	30
Carex flava	13	2	0	5
Filipendula ulmaria				

Art_S2-A-2a	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	3	4	-4	20
Aster 'Purple Dom'	10	9	0	60
Aster 'Snow Flurry'	5	7	-4	20
Calamagrostis 'Overdam'	6	7	0	140
Euphorbia	15	8	0	30
Anaphalis triplinervis	8	6	1	65
Gypsophila 'Pink Star'	5	7	1	40
Linaria purpurea	12	5	0	100
Salvia 'Mainacht'	7	5	-1	30
Paper atlanticum	6	3	0	40
Art_S2-B-2a	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	2	4	-2	110
Artemisia 'Silver Queen'	2	5	0	40
Aster 'Pink Star'	2	9	0	130
Echinacea purpurea	9	7	0	110
Gaura lindheimeri	2	3	-5	100
Liastris spicata	4	7	-1	60
Monarda- Hybride	5	7	0	120
Oenothra	2	7	0	25
Penstemon 'Huskers Red'	4	6	0	80
Tradescanthia ohiensis	1	3	0	20
Echinacea pallida	5	5	0	100
Parthenium integrifolium	1	6	-1	120
Pycnanthemum tenuifolium	7	6	-1	100
Solidago caesia	2	8	0	120
Aster divaricatus 'Tradescant'	12	7	3	70
Verbena bonariensis	3	6	0	130
Panicum virgatum	25% Coverage	5	-1	100
Art_S2-C-2a	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	2	3	0	5
Filipendula palmata 'Nana'	8	3	-1	25
Caltha palustris	2	8	0	20
Iris sibirica (Wildform)	4	8	0	100
Lobelia siphilitica	1	5	0	55
Lythrum salicaria	5	8	0	140
Persicaria officinalis	4	6	0	20
Typha minima	10.00%	7	1	70
Lobelia sessilifolia	6	7	0	120
Lychnis flos-cuculi	7	7	-1	5
Chelone obliqua	3	7	0	90
Carex flava	12	7	1	30
Cardamine pratense	0	-	-	-
Filipendula ulmaria	0	-	-	-

Art_S3-A-2a	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	5	4	-1	15
Aster 'Purple Dom'	11	8	0	50
Aster 'Snow Flurry'	7	6	0	20
Calamagrostis 'Overdam'	6	6	0	140
Euphorbia	8	3	0	10
Anaphalis triplinervis	8	6	0	60
Gypsophila 'Pink Star'	4	3	0	45
Linaria purpurea	3	2	0	20
Salvia 'Mainacht'	10	4	0	30
Paper atlanticum	5	4	0	30
Art_S3-B-2a	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	0	-	-	-
Artemisia 'Silver Queen'	2	2	0	30
Aster 'Pink Star'	2	4	0	80
Echinacea purpurea	6	5	0	80
Gaura lindheimeri	2	5	1	80
Liastris spicata	6	5	0	40
Monarda- Hybride	5	4	0	55
Oenothra	3	3	0	10
Penstemon 'Huskers Red'	2	3	0	40
Tradescanthia ohiensis	0	-	-	-
Echinacea pallida	5	5	0	100
Parthenium integrifolium	2	3	-1	30
Pycnanthemum tenuifolium	8	3	0	50
Solidago caesia	2	6	0	100
Aster divaricatus 'Tradescant'	8	5	1	50
Verbena bonariensis	0	-	-	-
Panicum virgatum	2	4	-1	110
Art_S3-C-2a	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	3	3	0	5
Filipendula palmata 'Nana'	8	4	0	5
Caltha palustris	0	-	-	-
Iris sibirica (Wildform)	4	5	0	95
Lobelia siphilitica	20	5	0	40
Lythrum salicaria	4	4	0	55
Persicaria officinalis	4	3	0	5
Typha minima	20.00%	7	0	60
Lobelia sessilifolia	5	4	0	70
Lychnis flos-cuculi	6	4	0	5
Chelone obliqua	4	3	0	40
Carex flava	13	4	0	10
Cardamine pratense	3	2	0	5
Filipendula ulmaria	5	5	0	30

Covered zone – Row b

Art_S1-A-2b	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	10	4	-1	25
Aster 'Purple Dom'	4	1	0	10
Aster 'Snow Flurry'	5	1	0	5
Calamagrostis 'Overdam'	5	2	-1	60
Euphorbia	15	5	1	20
Anaphalis triplinervis	8	6	-1	45
Gypsophila 'Pink Star'	5	7	5	45
Linaria purpurea	3	6	0	70
Salvia 'Mainacht'	8	6	-1	30
Paper atlanticum	0	-	-	-
Art_S1-B-2b	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	0	-	-	-
Artemisia 'Silver Queen'	2	1	-1	20
Aster 'Pink Spray'	0	-	-	-
Echinacea purpurea	6	4	0	35
Gaura lindheimeri	2	7	1	100
Liastris spicata	7	3	0	15
Monarda- Hybride	4	4	-1	50
Oenothra	1	1	0	5
Penstemon 'Huskers Red'	5	3	0	20
Tradescanthia ohiensis	2	1	0	0
Echinacea pallida	5	6	0	80
Parthenium integrifolium	2	5	-1	40
Pycnanthemum tenuifolium	10	4	0	55
Solidago caesia	2	5	0	80
Aster divaricatus 'Tradescant'	7	5	-1	50
Verbena bonariensis	0	-	-	-
Panicum virgatum	2	5	0	100
Baptisia australis	2	3	-1	60
Art_S1-C-2b	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	0	-	-	-
Filipendula palmata 'Nana'	2	1	0	5
Caltha palustris	1	2	0	5
Iris sibirica (Wildform)	4	4	0	45
Lobelia siphilitica	0	-	-	-
Lythrum salicaria	4	4	0	40
Persicaria officinalis	4	2	0	5
Typha minima	2	1	0	15
Lobelia sessilifolia	3	1	0	20
Lychnis flos-cuculi	0	-	-	-
Chelone obliqua	4	2	0	25
Carex flava	4	1	0	5
Cardamine pratense	0	-	-	-
Filipendula ulmaria	2	1	0	5

Art_S2-A-2b	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	0	-	-	-
Aster 'Purple Dom'	7	5	-7	35
Aster 'Snow Flurry'	6	5	-5	25
Calamagrostis 'Overdam'	6	6	0	140
Euphorbia	15-20%	7	0	30
Anaphalis triplinervis	6	7	-3	50
Gypsophila 'Pink Star'	60.00%	9	7	70
Linaria purpurea	8	7	0	100
Salvia 'Mainacht'	4	5	-3	40
Paper atlanticum	6	7	-1	25
Art_S2-B-2b	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	2	4	-5	90
Artemisia 'Silver Queen'	2	7	3	50
Aster 'Pink Star'	2	7	0	100
Echinacea purpurea	7	7	0	70
Gaura lindheimeri	2	7	0	100
Liatris spicata	3	4	-1	35
Monarda- Hybride	4	6	0	85
Oenothra	2	1	0	5
Penstemon 'Huskers Red'	5	5	-1	60
Tradescanthia ohiensis	2	1	0	5
Echinacea pallida	4	8	0	120
Parthenium integrifolium	2	4	4-6	50
Pycnanthemum tenuifolium	8	5	-1	60
Solidago caesia	2	5	0	100
Aster divaricatus 'Tradescant'	11	8	-1	120
Verbena bonariensis	4	7	0	120
Panicum virgatum	2	7	-1	120
Art_S2-C-2b	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	2	3	0	5
Filipendula palmata 'Nana'	10	2	-1	5
Caltha palustris	2	2	0	5
Iris sibirica (Wildform)	4	6	0	80
Lobelia siphilitica	13	4	-1	30
Lythrum salicaria	5	4	0	70
Persicaria officinalis	4	3	0	10
Typha minima	5	2	-1	10
Lobelia sessilifolia	2	3	0	35
Lychnis flos-cuculi	25% Coverage	7	1	55
Chelone obliqua	5	5	0	65
Carex flava	16	5	0	25
Cardamine pratense	0	-	-	-
Filipendula ulmaria	2	4	0	40

Art_S3-A-2b	Numbers 16	Vitality 16	Coexistence 16	Height 16
Achillea	10	4	-1	20
Aster 'Purple Dom'	11	5	0	40
Aster 'Snow Flurry'	10	5	1	10
Calamagrostis 'Overdam'	6	6	0	130
Euphorbia	6	3	0	10
Anaphalis triplinervis	8	4	-1	30
Gypsophila 'Pink Star'	5	4	1	35
Linaria purpurea	0	-	-	-
Salvia 'Mainacht'	10	4	0	25
Papaver atlanticum	0	-	-	-
Art_S3-B-2b	Numbers 16	Vitality 16	Coexistence 16	Height 16
Agastache	0	-	-	-
Artemisia 'Silver Queen'	2	3	0	40
Aster 'Pink Star'	2	5	0	110
Echinacea purpurea	9	5	0	90
Gaura lindheimeri	2	5	0	110
Liastris spicata	6	4	0	65
Monarda- Hybride	5	2	0	40
Oenothra	3	1	0	10
Penstemon 'Huskers Red'	3	2	0	50
Tradescanthia ohiensis	0	-	-	-
Echinacea pallida	4	5	0	80
Parthenium integrifolium	2	4	-1	50
Pycnanthemum tenuifolium	11	3	0	25
Solidago caesia	2	5	0	100
Aster divaricatus 'Tradescant'	15	5	0	60
Verbena bonariensis	0	-	-	-
Panicum virgatum	2	4	0	110
Art_S3-C-2b	Numbers 16	Vitality 16	Coexistence 16	Height 16
Ajuga reptans 'Atropurpurea'	3	2	0	5
Filipendula palmata 'Nana'	7	2	0	5
Caltha palustris	2	1	0	1
Iris sibirica (Wildform)	3	5	0	85
Lobelia siphilitica	40	4	0	35
Lythrum salicaria	5	4	0	75
Persicaria officinalis	3	2	0	10
Typha minima	5.00%	7	0	40
Lobelia sessilifolia	6	4	0	45
Lychnis flos-cuculi	8	2	0	5
Chelone obliqua	3	4	0	50
Carex flava	11	3	0	15
Cardamine pratense	0	-	-	-
Filipendula ulmaria	5	4	0	25

APPENDIX 8

2016- Bernburg - weeds' weight and time of collecting them

Open space

Nr. of plot	Total time per plot in Minutes	Total time per m² in Minutes	Total-weight per plot in gram	Total weight per m² in gram
S1-A-1x	4	0.27	38	2.53
S1-B-1x	2.5	0.17	99	6.60
S1-C-1x	6	0.40	233	15.53
S2-A-1x	1	0.07	0	0.00
S2-B-1x	8	0.53	28	1.87
S2-C-1x	30	2.00	1050	70.00
S3-A-1x	10	0.67	86	5.73
S3-B-1x	10	0.67	83	5.53
S3-C-1x	20	1.33	320	21.33

Covered zone (12 m²)

Nr. of plot	Total time per plot in Minutes	Total time per m² in Minutes	Total-weight per plot in gram	Total weight per m² in gram
S1-A-2a	3	0.25	5	0.42
S1-B-2a	1.5	0.13	9	0.75
S1-C-2a	3.5	0.29	40	3.33
S2-A-2a	2.5	0.21	3	0.25
S2-B-2a	4	0.33	34	2.83
S2-C-2a	53	4.42	960	80.00
S3-A-2a	5.5	0.46	37	3.08
S3-B-2a	6	0.50	19	1.58
S3-C-2a	12	1.00	136	11.33
S1-A-2b	1.5	0.13	0	0.00
S1-B-2b	2	0.17	3	0.21
S1-C-2b	3	0.25	41	3.42
S2-A-2b	1.5	0.13	3	0.25
S2-B-2b	3.5	0.29	27	2.25
S2-C-2b	24	2.00	600	50.00
S3-A-2b	7	0.58	41	3.42
S3-B-2b	8	0.67	38	3.17
S3-C-2b	56	4.67	586	48.83
S1-A-2c	1.5	0.13	15	1.25
S1-B-2c	2.5	0.21	14	1.17
S1-C-2c	3	0.25	45	3.75
S2-A-2c	2.5	0.21	50	4.17
S2-B-2c	13	1.08	228	19.00
S2-C-2c	44	3.67	1270	105.83
S3-A-2c	7	0.58	118	9.83
S3-B-2c	6	0.50	31	2.58
S3-C-2c	48	4.00	700	58.33

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